REFUSE PILE AMENDMENT

DUGOUT CANYON MINE

C/007/039

FEBRUARY 2003

Canyon Fuel Company, LLC
P.O. Box 1029
Wellington, UT 84542

VOLUME 2
CHAPTERS 5 - 9

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COPY

0009

February 13, 2003

Ms. Pamela Grubaugh-Littig
Department of Natural Resources
Division of Oil, Gas and Mining
1594 West North Temple
Suite 1210
Salt Lake City, UT 84114-5801

RE: Refuse Pile Amendment, Incorporation of Additional Information and Text for Refuse Pile, C/007/039 -SR02D-2, Canyon Fuel Company, LLC, Dugout Mine, C/007/039

Dear Ms. Grubaugh-Littig:

Enclosed please find four copies of the submittal to address questions and comments from UDOGM staff pertaining the refuse pile amendment submittal made January 2003. The changes required in Chapter 2, moved the text enough to change multiple pages requiring the entire chapter to be resubmitted. The changes in RA Attachment 7-4 although not extensive, made it necessary to provide a complete copy of the attachment to replace the currently submitted attachment. The changes in RA Attachment 7-4 have been provided in a highlighted form.

If you would like assistance in the incorporation of this information into the previous submittals, please contact either myself or Chris Hansen (435) 448-2669.

An additional copy of the submittal has been delivered to the Price Field Office.

Please contact Vicky Miller at (435) 636-2869 if there are any question concerning this submittal.

Sincerely yours,

Vicky S Miller

Vicky S. Miller

Cc: Chris Hansen (no enclosures)
Dave Spillman (enclosures)
Steve Demczak (enclosures)

APPLICATION FOR COAL PERMIT PROCESSING

Permit Change ☒ New Permit ☐ Renewal ☐ Exploration ☐ Bond Release ☐ Transfer ☐ **COPY**

Permittee: Canyon Fuel Company, LLC
Mine: Dugout Canyon Mine **Permit Number:** C/007/039
Title: Incorporation of Additional Information and Text for Refuse Pile, C/007/039 - SR02D-2
Description, Include reason for application and timing required to implement:

Instructions: If you answer yes to any of the first eight (gray) questions, this application may require Public Notice publication.

☒ Yes ☐ No 1. Change in the size of the Permit Area? Acres: 26.8 Disturbed Area: 26.8 ☒ increase ☐ decrease.
☐ Yes ☒ No 2. Is the application submitted as a result of a Division Order? DO# ____
☐ Yes ☒ No 3. Does the application include operations outside a previously identified Cumulative Hydrologic Impact Area?
☐ Yes ☒ No 4. Does the application include operations in hydrologic basins other than as currently approved?
☐ Yes ☒ No 5. Does the application result from cancellation, reduction or increase of insurance or reclamation bond?
☐ Yes ☒ No 6. Does the application require or include public notice publication?
☐ Yes ☒ No 7. Does the application require or include ownership, control, right-of-entry, or compliance information?
☐ Yes ☒ No 8. Is proposed activity within 100 feet of a public road or cemetery or 300 feet of an occupied dwelling?
☐ Yes ☒ No 9. Is the application submitted as a result of a Violation? NOV # ____
☐ Yes ☒ No 10. Is the application submitted as a result of other laws or regulations or policies?
Explain: ____
☐ Yes ☒ No 11. Does the application affect the surface landowner or change the post mining land use?
☐ Yes ☒ No 12. Does the application require or include underground design or mine sequence and timing? (Modification of R2P2)
☒ Yes ☐ No 13. Does the application require or include collection and reporting of any baseline information?
☐ Yes ☒ No 14. Could the application have any effect on wildlife or vegetation outside the current disturbed area?
☐ Yes ☒ No 15. Does the application require or include soil removal, storage or placement?
☒ Yes ☐ No 16. Does the application require or include vegetation monitoring, removal or revegetation activities?
☐ Yes ☒ No 17. Does the application require or include construction, modification, or removal of surface facilities?
☐ Yes ☒ No 18. Does the application require or include water monitoring, sediment or drainage control measures?
☐ Yes ☒ No 19. Does the application require or include certified designs, maps or calculation?
☐ Yes ☒ No 20. Does the application require or include subsidence control or monitoring?
☐ Yes ☒ No 21. Have reclamation costs for bonding been provided?
☐ Yes ☒ No 22. Does the application involve a perennial stream, a stream buffer zone or discharges to a stream?
☐ Yes ☒ No 23. Does the application affect permits issued by other agencies or permits issued to other entities?

Please attach four (4) review copies of the application. If the mine is on or adjacent to Forest Service land please submit five (5) copies, thank you. (These numbers include a copy for the Price Field Office)

I hereby certify that I am a responsible official of the applicant and that the information contained in this application is true and correct to the best of my information and belief in all respects with the laws of Utah in reference to commitments, undertakings, and obligations, herein.

David G. Spillman
Print Name

David G. Spillman Engineering Manager 2/13/03
Sign Name, Position, Date

Subscribed and sworn to before me this 13 day of February, 2003

Dionne M Oman
Notary Public

My commission Expires: 12-15, 2006 }
Attest: State of Utah } ss:
County of Carbon

DIONNE M. OMAN
NOTARY PUBLIC • STATE of UTAH
1015 EAST 2640 SOUTH
PRICE, UTAH 84501
COMM. EXPIRES 12-15-2006

For Office Use Only:	**Assigned Tracking Number:**	**Received by Oil, Gas & Mining**
		RECEIVED FEB 13 2003 DIV. OF OIL, GAS & MINING

Form DOGM- C1 (Revised March 12, 2002)

APPLICATION FOR COAL PERMIT PROCESSING
Detailed Schedule Of Changes to the Mining And Reclamation Plan

COPY

Permittee: Canyon Fuel Company, LLC
Mine: Dugout Canyon Mine **Permit Number:** C/007/039
Title: Incorporation of Additional Information and Text for Refuse Pile, C/007/039 - SR02D-2

Provide a detailed listing of all changes to the Mining and Reclamation Plan, which is required as a result of this proposed permit application. Individually list all maps and drawings that are added, replaced, or removed from the plan. Include changes to the table of contents, section of the plan, or other information as needed to specifically locate, identify and revise the existing Mining and Reclamation Plan. Include page, section and drawing number as part of the description.

Add	Replace	Remove	DESCRIPTION OF MAP, TEXT, OR MATERIAL TO BE CHANGED
☐	☒	☐	Refuse Pile, Chapter 1, Page 1-iii
☐	☒	☐	Refuse Pile, Chapter 2, Pages 2-1, 2-2 , 2-5, 2-6 and 2-14, entire Chapter has been provided
☐	☒	☐	Refuse Pile, Chapter 3, Page 3-20
☐	☒	☐	Refuse Pile, Chapter 7, Pages 7-v, 7-3, 7-5, 7-10, 7-12, and 7-28
☒	☐	☐	RA Attachment 5-4, add data provided to the back of the existing information
☐	☒	☐	RA Attachment 7-4, Pages 2, 8, 9, 33 (revisions are highlighted), entire Attachment provided
☒	☐	☐	RA Attachment 7-5, Climatological Informaion
☒	☐	☐	RA Attachment 7-6, Soldier Canyon Plate 7-1
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Any other specific or special instruction required for insertion of this proposal into the Mining and Reclamation Plan.	Received by Oil, Gas & Mining
2-13-03	RECEIVED FEB 13 2003 DIV. OF OIL, GAS & MINING

CHAPTER 5

ENGINEERING

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CHAPTER 5

ENGINEERING

510 INTRODUCTION

This chapter provides a discussion of general engineering aspects, an operation plan, a reclamation plan, design criteria, and performance standards related to the refuse pile. The activities associated with the construction and reclamation of the refuse pile will be designed, located, constructed, maintained, and reclaimed in accordance with the operation and reclamation plans.

511 General Requirements

This permit application includes descriptions of the proposed refuse pile area construction, maintenance, and reclamation operations together with the appropriate maps, plans, and cross sections. Potential environmental impacts as well as methods and calculations utilized to achieve compliance with the design criteria are also presented.

512 Certification

Where required by the regulations, cross sections and maps in this permit application have been prepared by or under the direction of, and certified by, qualified registered professional engineers, geologist or land surveyors. As appropriate, these persons were assisted by experts in the fields of hydrology, geology, biology, etc.

512.100 Cross Sections and Maps

The configuration of the refuse pile and cross sections through the pile are provided on RA Plates 5-1 and 5-1A of this submittal. An as-built map of the refuse pile topography (Olympus Aerial Survey, May 2003) is included in Attachment 5-5.

512.200 Plans and Engineering Designs

All plans and engineering designs presented in this submittal were prepared by or under the direction of and certified by a qualified registered professional engineer.

Excess Spoil. No excess spoil will be generated from the refuse pile area.

Durable Rock Fills. No durable rock fills will exist in the refuse pile area.

Coal Mine Waste. If coal mine waste is generated by the Dugout Canyon Mine, it will be placed in the refuse pile site.

Impoundments. A sedimentation pond impoundment was built in the refuse pile area (see Section 732).

Primary Roads. The access road to the refuse pile and the temporary road to construct the refuse pile are classified as primary roads.

Variance From Approximate Original Contour. CFC does not request a variance from the approximate original contour requirements of the regulations for this site. The proposed configuration of the site will comply with the post-mining land use and blend into the surrounding area.

513 Compliance with MSHA Regulations and MSHA Approvals

513.100 Coal Processing Waste Dams and Embankments

No coal processing waste dams or embankments will exist within the permit area.

513.200 Impoundments and Sedimentation Ponds

No impoundments or sedimentation ponds in the permit area meet the size criteria of 30 CFR 77.216(a).

513.300 Underground Development Waste, Coal Processing Waste, and Excess Spoil

If underground development waste is generated by the Dugout Canyon Mine, it will be stored at the refuse pile site. Coal processing waste will be stored at the refuse pile site. No excess spoil will be generated or stored within this area.

513.400 Refuse Piles

Coal mine waste or underground development waste generated by the Dugout Canyon Mine, will be stored at the refuse pile site. The design of the pile will meet the requirements of MSHA, 30 CFR 77.124 and 30 CFR 77.215 in accordance with Section 536.900.

513.500 Underground Openings to the Surface

No underground openings will be present in this area.

513.600 Discharges to Underground Mines

No discharges to underground mines will occur in this area.

513.700 Surface Coal Mining and Reclamation Activities

No surface coal mining and reclamation activities will occur in this area.

513.800 Coal Mine Waste Fires

If any coal mine waste fires occur within the permit area, these will be reported immediately to MSHA and the Division. Immediate remedial action will be taken as deemed necessary by CFC to protect public health and safety as well as the environment. Following initial remedial efforts, a long-term plan will be formulated in discussion with MSHA and the Division to extinguish any existing fires and prevent future fires.

CFC will utilize a program of prevention and suppression to minimize the potential for coal mine waste fires. An ongoing educational program will emphasize the need for attention to fire prevention. Suppression will occur by separating smoldering material and compacting the adjacent material (to minimize oxygen content in the adjacent material). The burning material will then be extinguished using appropriate methods (see Section 528.300 of the approved M&RP and Section 536.200 of this amendment). No burning mine waste will be removed from the refuse pile area without a removal plan approved by the Division.

514 Inspections

514.100 Excess Spoil

Excess spoil will not be stored in this area.

514.200 Refuse Piles

Quarterly inspections will be made of the refuse pile area (see RA Plate 5-1). These inspections will be performed by a professional engineer or a specialist experienced in the construction of similar earth and waste structures. CFC will provide copies of the certified reports to the Division in the annual report. The report will discuss any appearances of instability, structural weakness, or other hazardous conditions. A copy of this report will be maintained at the mine site.

An MSHA permit was obtained before any refuse was placed in the pile area. All activities performed at this site will be in accordance with the applicable MSHA permit.

514.300 Impoundments

Regular inspections were made during construction of the sedimentation pond as well as upon completion of construction. These inspections were made by or under the direction of a registered professional engineer experienced in the construction of similar earth and water structures.

Quarterly inspections of the sedimentation pond will continue until removal of the structure or release of the performance bond. An annual certified report of inspection will be prepared by a qualified registered professional engineer and submitted to the Division in the annual report. The report will discuss any appearances of instability, structural weakness or other hazardous conditions, depth and elevation of any impounded waters, existing storage capacity, and existing or required monitoring procedures and instrumentation, and any other aspects of the structure affecting stability. A copy of this report will be maintained at the mine site.

No impoundments are anticipated within the permit area that are subject to 30 CFR 77.216.

515 Reporting and Emergency Procedures

515.100 Slides

If a slide occurs within the refuse pile area that may have a potential adverse effect on the public, property, health, safety, or the environment, CFC will notify the Division following discovery of the slide and will comply with any remedial measures required by the Division.

515.200 Impoundment Hazards

If any examination or inspection of an impoundment discloses that a potential hazard is associated with that impoundment that may have an adverse effect on the public, property, health, safety, or the environment, the person who examined the impoundment will promptly inform the Division of the finding and of the emergency procedures formulated for public protection and remedial action. If adequate procedures cannot be formulated or implemented, the Division will be notified.

515.300 Temporary Cessation of Operations

Prior to a temporary cessation of operations within the permit area that will last for a period of 30 days or more or as soon as it is known that a temporary cessation will extend beyond 30 days, CFC will submit to the Division a notice of intention to cease or abandon operations. This notice will include the following:

A statement of the number of surface acres affected by mining operations in the permit area prior to cessation of operations,

A discussion of the extent and kind of reclamation activities which will have been accomplished prior to cessation of operations, and

An identification of the backfilling, regrading, revegetation, environmental monitoring, and water treatment activities that will continue during the temporary cessation.

During the temporary cessation, CFC will secure surface facilities in areas in which there are no current operations but where future operations are to be resumed under an approved permit.

520 OPERATION PLAN

521 General

521.100 Cross Sections and Maps

Existing Surface and Subsurface Facilities and Features. No buildings are located in and within 1000 feet of the refuse pile area. No surface or subsurface features are within, passing through or passing over the refuse pile area. An existing county road bypasses the area. The county road lies on land either owned by the State of Utah, the United States of America, or Canyon Fuel Company, LLC (see Plate 1-3 of the approved M&RP).

Landowner, Right-of-Entry, and Public Interest. CFC is the current land owner of the property where the refuse pile is built. It is located adjacent to the county road to Dugout Canyon. Public access will be limited to the site by construction of a suitable fence and gate. The contiguous surface owners are the United States of America and Canyon Fuel Company, LLC (See Figure RA 1-1B of this submittal). The contiguous subsurface owner is the United States of America (See Figure RA 1-1B of this submittal).

Mining Sequence and Planned . This does not apply to this site (see Section 525).

Land Surface Configuration. Surface contours of undisturbed areas within the storage area are provided on RA Plate 5-1 of this submittal. The initial segment of the refuse pile was constructed in a gravel pit. The first four (4) feet of refuse material was used to fill a pit and bring it to grade. The remainder of the refuse material will be placed above grade and reach a total pile height of sixty (60) feet above portions of the immediate surrounding area as provided on RA Plate 5-1 of this submittal. As shown on RA Plate 1-1, the hills surrounding the site range in elevation from 5887 to 6283, therefore the reclaimed elevation of the refuse pile of 5980 to 6000 will blend with the surrounding area.

Surface Facilities. The surface facilities associated with the refuse pile site include: the refuse pile, temporary material/snow storage areas, soil stockpiles, access road, sedimentation pond, and drainage control structures. Facilities are shown or mentioned on RA Plate 5-1. Detailed information on sedimentation pond and drainage facilities is presented in Chapter 7 of this submittal. Cross sections of the refuse storage pile(s) are provided on RA Plate 5-1.

Transportation Facilities. A permanent road is not anticipated to be constructed, used, or maintained by CFC in the storage area. During construction of the pile, temporary access roads will be constructed and maintained. The temporary roads will be reclaimed and seeded with the permanent reclamation seed mix (Section 341.200 of this amendment). Refer to RA Attachment 5-6 for drawings of the paved access road.

521.200 Signs and Markers

Mine and Permit Identification Signs. A mine and permit identification sign will be displayed at the refuse pile site. This sign will be a design that can be easily seen and read, will be made of durable material, will conform to local regulations, and will be maintained until after the release of all bonds for the permit area. The sign will contain the following information:

Mine name,
Company name,
Company address and telephone number,
MSHA identification number, and
Permanent program permit identification number as obtained from the Division.

Perimeter Markers. The perimeter of all areas affected by surface operations were clearly marked before beginning mining activities. The markers will be a design that can be easily seen and will be made of durable material, will conform to local regulations, and will be maintained until after the release of all bonds for the permit area.

Buffer Zone Markers. Stream buffer zone markers are not required for this area.

Topsoil Markers. Markers will be placed on all soil stockpiles. These markers will be a design that can be easily seen and read, will be made of durable material, will conform to local regulations, and will be maintained until after the release of all bonds for the permit area.

522 Coal Recovery

No coal recovery will be performed at this site.

523 Mining Methods

No mining will be performed at this site.

524 Blasting and Explosives

No explosives are to be used at this site.

525 Subsidence

No subsidence will occur in this area, because no underground coal mining will occur beneath the refuse pile site. Therefore, there will be no effects on the site from coal mining related subsidence.

526 Mine Facilities

526.100 Mine Structures and Facilities

No buildings exist or are proposed at the refuse pile site; therefore, no existing buildings will be used in connection with or to facilitate this proposed coal mining and reclamation operation.

526.200 Utility Installation and Support Facilities

No utilities are to be installed at this site.

527 Transportation Facilities

527.100 Road Classification

No permanent roads are to be built in association with the construction of the refuse pile. A temporary road will be used to access the site. The access road to the refuse pile and the temporary road to construct the refuse pile are classified as primary roads. Refer to Section 521.100 of this amendment for additional detail.

The existing road to access the site from the Dugout Canyon Road will be paved to provide all weather access to the site. The road will have a guard rail constructed to comply with engineering, UDOT and MSHA requirements. Refer to RA Attachment 5-6 for drawings of the road.

527.200 Description of Transportation Facilities

The access road to the refuse pile site follows the alignment of an existing road shown on RA Plate 7-1. The access road is approximately 840 feet long and will have paved surface approximately 20 feet wide. The access road will have a maximum grade of 16% and an average grade of 10%. The road will gently slope towards UD-1c which drains to culvert UC-1 (See cross-section RA Figure 5-1 2). The road does not cross any natural drainage. Culvert, UC-1, was installed at the intersection of the access road and the county road, to allow free flow of the runoff in the county road borrow ditch. Specific design information for the culvert is provided in RA Attachment 7-4.

The temporary access road is shown on RA Plate 5-1. The road is approximately 20 feet wide and is constructed on compacted subsoil. The road will have an uniform grade of 2% within the site (See cross-section RA Figure 5-2). The runoff from the road will flow into drainage ditches and then into the sediment pond.

During operations, the access road and temporary access road will be maintained using a road grader and any other equipment which may be necessary to ensure compliance. Drainage ditches will be maintained to ensure proper functioning.

Accidental spillage of coal mine waste during haulage from the mine site to the refuse pile will be minimized by not overloading the haulage trucks. Accidental spills, if they occur, will be cleaned up and transported to the refuse site, in a timely manner.

If a catastrophic events causes damage to access roads, the rapid repair of the road/roads will begin as soon as practical following the catastrophic damage.

528 Handling and Disposal of Coal, Excess Spoil, and Coal Mine Waste

Coal mine waste and/or underground development waste materials generated at the Dugout Mine, will be transported to the refuse site and disposed of in a controlled manner in accordance with Section 536. Construction of the refuse pile will meet MSHA and DOGM requirements in accordance with the approved plan.

Non-coal and hazardous wastes will not be disposed of in the refuse pile. They will be handled in accordance with the approved M&RP.

529 Management of Mine Openings

No mine openings will be built in the area.

530 OPERATIONAL DESIGN CRITERIA AND PLANS

531 General

This section contains the general plans for the construction of the sediment control measures and general construction and maintenance of the refuse pile area. This site will be used by CFC to handle coal mine waste or underground development waste that may be generated by the Dugout Mine. Also, a portion of the site will be used as a temporary storage yard for mine materials and a place for disposal of excess snow from the Dugout Mine site.

During operations, the runoff from the site area will be treated through the use of sediment controls such as diversion ditches and berms, a sediment pond, and silt fences and/or straw bales. These structures will be constructed, to handle the site runoff, before the initial refuse is placed.

532 Sediment Control

Sediment-control measures for the site area are described in detail in Sections 732 and 742 of this submittal. Runoff-control structures at the refuse pile area have been designed to convey runoff in a non-erosive manner. Sediment yields in the permit area are minimized by, disturbing the smallest practicable area during the construction or modification of surface facilities and contemporaneously reclaiming areas suitable for such reclamation.

533 Impoundments

533.100 Slope Stability

The only impoundment with an embankment that will be constructed, used, or maintained by CFC will be the sedimentation pond at the refuse pile site. This pond is an incised pond with an embankment consisting of native materials. A slope-stability analysis was performed on this pond embankment material and is provided in RA Attachment 5-1. According to this analysis, the minimum safety factor for the sedimentation pond embankment is 1.9 under static moist conditions. Furthermore, the analysis presented in RA Attachment 5-1 indicates that a minimum safety factor of 2.2 will exist for the embankment under conditions of rapid drawdown. All analyses were performed assuming that the pond was full to its maximum design depth. These safety factors exceed the minimum requirements of R645-301-533.100.

533.200 Foundation Considerations

Soils investigations have been conducted at the site of the refuse pile area. Results of these investigations are presented in Chapter 2 and RA Attachment 5-1 of this submittal. During these investigations, foundation conditions in the area of the proposed sedimentation pond were evaluated. Based on these investigations, no conditions were encountered which suggested that the materials in which the pond would be constructed would be unstable. The slope-stability analyses presented in RA Attachment 5-1 indicate that the pond embankments will also be stable under operating conditions. Detailed cross sections of the sedimentation pond are presented on RA Plate 7-2 of this submittal.

533.300 Slope Protection

The inslopes of the sedimentation pond and portions of the outslope disturbed by the spillway construction were revegetated following construction to minimize surface erosion and protect the embankments against sudden drawdown. The interim seed mix was used for this revegetation effort (see Section 341.200 of this submittal).

Rapid drawdown in the sedimentation pond would be restricted to pumping the vertical distance between the spillway and the pond bottom, a distance of 11 feet (see RA Plate 7-2). Drawdown of this magnitude and rate is not considered significant and, therefore, not a stability or erosion concern. The analysis presented in RA Attachment 5-1 indicates that the slope of the embankment will be stable under conditions of rapid drawdown (minimum safety factor of 2.2). During pumping of the sedimentation pond, flow rates (and drawdown) will be controlled. Hence, it is unlikely that this drawdown will cause surface erosion of the embankment face.

533.400 Embankment Faces

Embankment inslopes and portions of the outslopes were revegetated following construction of the sedimentation pond, as outlined in Section 533.300. Riprap will also be placed on the upstream face of the embankment near the emergency spillway structure.

533.500 Highwalls

No highwalls will be located below the discharge lines of the sedimentation pond.

533.600 MSHA Criteria

The sedimentation pond does not meet the size criteria of 30 CFR 216(a).

533.700 Pond Operation and Maintenance Plans

The sedimentation pond has been designed as a total containment pond to contain the 100-year, 24-hour storm event, plus an adequate freeboard. Details of the design and the requirements for operation and maintenance of the pond are presented in Chapter 7 of this submittal.

534 Roads

534.100 Location, Design, Construction, Reconstruction, Use, Maintenance, and Reclamation

No permanent roads will be constructed in the storage area. The refuse will be transported to the refuse pile area using the existing county road. A temporary access road between the refuse pile area and county road will be constructed to allow equipment access to the pile. The temporary road will be reclaimed. The temporary road will be maintained in accordance with the approved M&RP. Refer to Section 527.200 for additional description of the transportation facilities.

Control of Damage to Public or Private Property. Roads will be designed in accordance with applicable county and State standards. By designing according to these standards, damage to public or private property will be been minimized.

Road Surfacing. The county road surface, which accesses the mine site, consists of asphalt. The temporary access road surface material will be surfaced with asphalt. No acid- or toxic-forming materials will be used in the road surfaces. The characteristics of the substances used for road surfaces will be nonacid-and nontoxic-forming. The roads are not established on constructed lands and road slopes are less than 2:1.

534.200 Environmental Protection and Safety

The design and construction of the temporary road will be in accordance with Section 534.200 of the approved M&RP.

534.300 Primary Roads

The access road to the refuse pile will be constructed in accordance with the requirements of Section 534.300 of the M&RP.

535 Spoil

No spoil will be generated in the refuse pile permit area.

536 Coal Mine Waste

Coal mine and underground development waste resulting from mining activities at the Dugout Canyon Mine will be disposed of at the refuse pile.

536.100 Design

The designs and their associated evaluations were based on the results of detailed foundation and laboratory analyses of soils at the site of the refuse pile. These results are presented in RA Attachment 5-2 of this submittal.

Based on the materials encountered in the refuse pile site area, the refuse pile can be constructed to an approximate height of 60 feet with 2H:1V outslopes on the native alluvial soils and have a static safety factor of 1.59 for failure surfaces starting in the refuse and terminating in the underlying soils. If the weathered Mancos Shale, which is present over the majority of the site, is used in the evaluation, the static safety factor rises to 2.38 for the 60-foot height pile configuration. For failure surfaces originating and terminating in the refuse materials, the pile has a static safety factor of 2.27. Therefore, the proposed pile configuration meets the minimum regulatory requirements. Because the effects of bedrock were not included in the analyses, the results are considered to be conservative. RA Plate 5-1 presents the proposed configuration of the refuse pile. RA Plate 5-2 shows the reclamation topography and treatment for the refuse pile. Reclamation cross sections are shown on RA Plate 5-2A . The reclaimed refuse pile will have concave slopes with 2:1 slopes near the top of the pile and 3:1 slopes or less at the toe of the reclaimed slope. The top of the reclaimed pile will be regraded to have an irregular plateau surface that drains towards all pile outslopes instead of draining only towards one side of the pile. The top of the reclaimed refuse pile will have slopes of 6:1 or less. Where possible the reclaimed slopes will be varied to blend into the shape of undisturbed areas. Outslopes of the reclaimed pile will be varied as much as possible to prevent long straight surfaces with uniform slopes.

Storage capacity of the pile is estimated to be approximately 1,018,792 tons of refuse. Calculations are presented in RA Attachment 5-3.

536.200 Waste Emplacement

Construction. Prior to the start of refuse pile construction, the appropriate sediment control facilities (sediment pond, undisturbed diversion ditch/berm, and disturbed area diversions) described in Chapter 7 were in place. Since initial waste rock storage will occur in an area 4 feet below natural grade, it is anticipated that ditches DD-1 and DD-2 will be constructed to their full extent only after waste reaches a level equal to the currently existing ground surface. An interim berm will be constructed to direct surface runoff away from the storage area below grade and toward ditch DD-3 and the sediment pond. RA Plate 5-1 presents the layout of the refuse pile areas.

Vegetative cover will be removed from the refuse site area, prior to placement of any coal mine or underground development waste. Soil materials shall be removed, stockpiled, and properly protected for future use in reclaiming the site. As the site has previously been disturbed there is no topsoil present. CFC commits to reasonable mechanized efforts to collect the maximum amount of soil materials still present on the site. It is anticipated that all suitable soil materials down to the Mancos Shale will be stripped. The soil materials salvaged from the strip area will be stored in the soil stockpile. The details of the soil salvage operations and estimates of the volume of soil to be stripped are presented in Chapter 2.

Once the soils have been stripped from the area, the refuse material will be placed. Based on prior experience, the refuse materials anticipated to be generated by the mine will generally consist of shale with some sandstone, bone coal, and in limited quantities, sandstone from paleochannels.

Sediment pond wastes from either the mine site or refuse area sediment pond will be stored in the refuse pile.

Coal processing waste to will be stored at the refuse site, should economics justify the washing of coal. Waste stored at the refuse site will be hauled to a wash facility for processing and the waste material not shipped to customers will be returned to the Dugout refuse site for disposal. The waste material returned to the Dugout refuse site could be from any of the Canyon Fuel mines. Waste material from other than Dugout Mine will be approved by the Division prior to placement at the Dugout refuse site. The returned waste materials will be sampled as described below under the subheading "Testing".

Operation. Refuse materials will be hauled to the site using either belly dump trailers or end dump trucks. At the refuse site, the trucks will deposit the refuse on a fill bench, where it will be spread and compacted by truck and equipment traffic. Successive lift will be allowed to drain (when necessary) before it is capped with the next lift in the construction sequence.

The gradation of the refuse material will most likely be coarse and poorly graded with a small percentage of fine materials. Therefore, it is necessary to rework and level the lifts to assist in achieving the desired densities and prevent the formation of large voids. Additional compaction of each lift can be accomplished by routing the loaded haul trucks over the lift surface in such a manner as to cover the surface uniformly.

Waste rock loads containing non-cemented, soft shale, clay, or fine-grained materials shall be mixed with coarser graded loads in a controlled manner to limit concentrations of fine materials within the fill. This will be especially true for sediment pond wastes from either the mine site or refuse area sediment pond.

All lifts will be emplaced in a controlled manner to ensure the mass stability of the refuse pile and prevent mass movement during and after construction. Additionally, the lifts shall be graded to promote drainage off the pile surface. No intentional impoundments will be created by the placement of the refuse materials.

As the limits of the site area are reached laterally, the outer slope shall conform to the slope indicated in RA Plate 5-1.

Maintenance. Coal mine and underground development waste may have high moisture content. Controlled placement and compaction of the refuse materials will minimize the potential for spontaneous combustion or ignition of these materials. In the unlikely event that any burning waste is found during the regular inspections of the refuse pile area, it will be separated and extinguished either by burying the burning materials or by using water sprays. Once extinguished, the material will be placed, compacted, and buried on the active refuse pile bench.

Testing. Due to the anticipated coarse, open graded nature of the refuse materials, most quality control work for the fill will have to be on a visual basis. Conventional in-place density tests will not give reliable results under these circumstances.

Based on analyses of the materials that have been encountered in the Dugout Canyon Mine and other CFC mines to date, no acid-forming problems are anticipated. When the site is receiving materials, a representative sample will be collected of the material at a rate of one sample per 2,000 cubic yards of material through the fourth quarter of 2005 and one sample per 5,000 cubic yards of material, thereafter. These samples will be analyzed for the parameters listed in Table 6 of the Division's topsoil and overburden guidelines (Leatherwood and Duce, 1988). Analyses reports of the sampled waste rock will be submitted with the annual report.

Should a problem be identified, a mitigation plan will be prepared and submitted to the Division for approval. All identified potential acid or toxic-forming materials will be buried after the material handling plan is approved by the Division.

Copies of the toxicity/acid-base results from the samples collected at the Dugout Canyon Mine are presented in RA Attachment 5-4 and Appendix 5-7 of the approved M&RP.

537 Regraded Slopes

537.100 Division Approval

No mining or reclamation activities will be conducted in the refuse pile permit area that require approval of the Division for alternative specifications or for steep cut slope.

537.200 Regrading of Settled and Revegetated Fills

Upon completion of the filling of the refuse pile, the site will be reclaimed. The refuse fill will be constructed in a prudent manner to ensure that the pile will be stable. Geotechnical analysis of the proposed configuration is presented in RA Attachment 5-2.

Based on the proposed construction plans, the pile will be constructed to achieve the final configuration. Following completion of the construction, the pile surface will be prepared for soil distribution and revegetation according to plans presented in Chapter 2 and 3 of this submittal.

540 RECLAMATION PLAN

541 General

541.100 Commitment

Upon the permanent cessation of coal mining and reclamation operations at the Dugout Canyon Mine, CFC will close, backfill, or otherwise permanently reclaim all affected areas in accordance with the R645 regulations and this reclamation plan.

541.200 Surface Coal Mining and Reclamation Activities

No surface coal mining and reclamation activities will be conducted in the permit area.

541.300 Underground Coal Mining and Reclamation Activities

No underground activities are planned for this site.

541.400 Environmental Protection Performance Standards Performance Standards

The plan presented herein is designed to meet the requirements of R645-301 and the environmental protection performance standards of the State Program.

542 Narratives, Maps, and Plans

542.100 Reclamation Timetable

A timetable for the completion of each major step in the reclamation plan is presented in RA Figure 5-1. The first phase consists of regrading the site, placing soil, surface roughening, and seeding (vegetating) the site. This phase will take approximately six (6) months to complete based on the number and anticipated types of construction equipment to be used, the number of operators and laborers necessary to complete the work, and the number of weather days (when work cannot take place) anticipated to occur. Work will be completed sooner if bad weather is not encountered. The second phase will be an approximate 10 month period where the success of the surface reclamation will be evaluated in relation to the surface roughening and the initial seeding success. If the surface roughening and/or initial reseeding (vegetation) does not appear successful, additional seeding or reworking of portions of the reclaimed surface may be necessary.

542.200 Plan for Backfilling, Soil Stabilization, Compacting, and Grading

Based on the proposed construction plans, the pile will be constructed so that the pile will be at final configuration when the disposal of waste is completed. Therefore, it is anticipated that little regrading will need to be conducted. The construction plans for the refuse pile area were designed to meet the objectives of maximizing refuse storage quantities and maintaining a geotechnically stable base. The primary features of this plan are:

Constructing a 2H to 1V outslope for the refuse pile;

Placement of soil;

Revegetation and mulching of the soiled site; and

Breaching and filling of the sedimentation pond with embankment materials.

Following completion of the construction, the pile surface will be prepared for soil distribution from the soils in the stage storage area. The quantity of soil cover required for the refuse pile facility is discussed in Section 242 of this amendment.

Grading activities during operations will develop a pile with a final surface configuration approximating that defined by RA Plates 5-1. Once this final surface is achieved, the top two feet of the surface not be compacted or the surface will be ripped to prepare it for soil spreading. Details regarding soil placement and revegetation following regrading are provided in Chapters 2 and 3, respectively.

Sedimentation Pond Removal and Interim Sediment Control. The sedimentation pond will be retained for as long as practical during reclamation. Because the pond is constructed as an incised structure, the pond reclamation will consist primarily of breaching the pond and pushing the embankment into the pond to create a gentle slope. The emergency spillway outlet channel will be removed and the rock from the spillway will be used in the construction of reclaimed channel RD-1c. During reclamation the berm materials of the diversion ditches around the refuse pile will be pushed into the ditch and a free draining slope will be constructed to allow runoff from the pile site to enter the natural drainages. Once the sediment pond and ditch areas are adequately graded, the soil materials will be redistributed and revegetated in accordance with Chapters 2 and 3.

542.300 Final Surface Configuration Maps and Cross Sections

Final surface configuration maps and cross sections for the Dugout Canyon refuse pile site are provided on RA Plates 5-2 and 5-2A. The topography illustrated on RA Plate 5-2 shows the proposed pile configuration and the proposed final configuration of the ground surface. RA Plate 5-2A presents final configuration cross-sections of the refuse pile site.

542.400 Removal of Temporary Structures

No surface structures are planned to be associated with the refuse pile operation.

542.500 Removal of Sedimentation Pond

Refer to Section 542.200 of this amendment.

542.600 Roads

All temporary access roads constructed during refuse pile construction activities will be reclaimed when no longer needed for access to the site. Any surfacing material will be removed, the area will be regraded, ripped, and the final reclamation seed mix will be applied as specified in Chapter 3.

542.700 Final Abandonment of Mine Openings and Disposal Areas

No mine openings or disposal areas will exist in this area.

542.800 Estimated Cost of Reclamation

Refer to the existing M&RP. It is anticipated that the cost of reclamation of the refuse pile is adequately covered within the existing Dugout Canyon Mine reclamation bond.

550 RECLAMATION DESIGN CRITERIA AND PLANS

551 Casing and Sealing of Underground Openings

No underground openings will exist in the area.

552 Permanent Features

552.100 Small Depressions

No small depressions will be created as part of the refuse pile construction and reclamation. Additionally, the original topographic divide that existed on the site pre-disturbance will be enhanced as part of the refuse pile construction plan.

552.200 Permanent Impoundments

No permanent impoundments will be left following reclamation.

553 Backfilling and Grading

553.100 Disturbed Area Backfilling and Grading

Approximate Original Contour. As indicated earlier, the site of the refuse pile is a previously disturbed site. The proposed configuration of the site will comply with the post-mining land use and blend into the surrounding area.

Based on the proposed plan, a portion of the existing ground surface will be raised by the construction of the refuse pile. Prior to placing refuse, the soils present on the site will be stripped and temporarily stored on site. At final reclamation, the stored soil will be redistributed and revegetated as described in Chapters 2 and 3 of this submittal.

The reclaimed slopes of the refuse pile will have a similar shape to the slopes in the surrounding area, including concave slopes and slope breaks. The top of the reclaimed pile will be regraded to have an irregular plateau surface that drains towards all pile outslopes instead of draining only towards one side of the pile (refer to RA Plates 5-2 and 5-2A).

Erosion and Water Pollution. Sediment-control measures will be implemented during and following reclamation activities.

Prior to seeding, all areas with a slope steepness of 3H:1V or steeper will be roughened using a trackhoe. The final surface will consist of mounds and depressions capable of holding runoff. Refer to Sections 355 and 341 regarding erosion-control and revegetation.

During these activities temporary sediment controls will consist of installation of silt fences, berms, and/or straw bales, surface roughening, and re-establishment of the vegetative cover for the limited areas. As vegetation becomes established on the reclaimed surfaces, erosion potentials will be further minimized. By minimizing erosion, water pollution will also be precluded.

Post-Mining Land Use. The disturbed area will be reclaimed in a manner that supports the approved post-mining land use.

553.200 Spoil and Waste

Spoil. No spoil will be generated within the permit area.

Coal Processing Waste. No coal processing waste will be generated within the permit area. However, should coal from the CFC mines be processed at a washing facility, there is potential for the processing waste to be returned to the refuse pile site for disposal.

553.250 Refuse Piles

The refuse pile site is a previously disturbed area. The site is to be located in a played out gravel pit. Therefore, little soil materials remain available on the site. The refuse pile surface will be prepared and the soil will be distributed and revegetated in accordance with the plans proposed in Chapters 2 and 3.

553.300 Exposed Coal Seams, Acid- and Toxic-Forming Materials, and Combustible Materials

No coal seams are present in the area.

553.400 Cut-and-Fill Terraces

No cut-and-fill terraces will be built at the site.

553.500 Highwalls From Previously Mined Areas

No highwalls exist or will be built at the refuse pile site.

553.600 Previously Mined Areas

The area has not been previously mined.

553.700 Backfilling and Grading - Thin Overburden

Backfilling and grading will occur during reclamation, as described in Sections 534.100 and 542.600.

553.800 Backfilling and Grading - Thick Overburden

Backfilling and grading will occur during reclamation, as described in Sections 534.100 and 542.600.

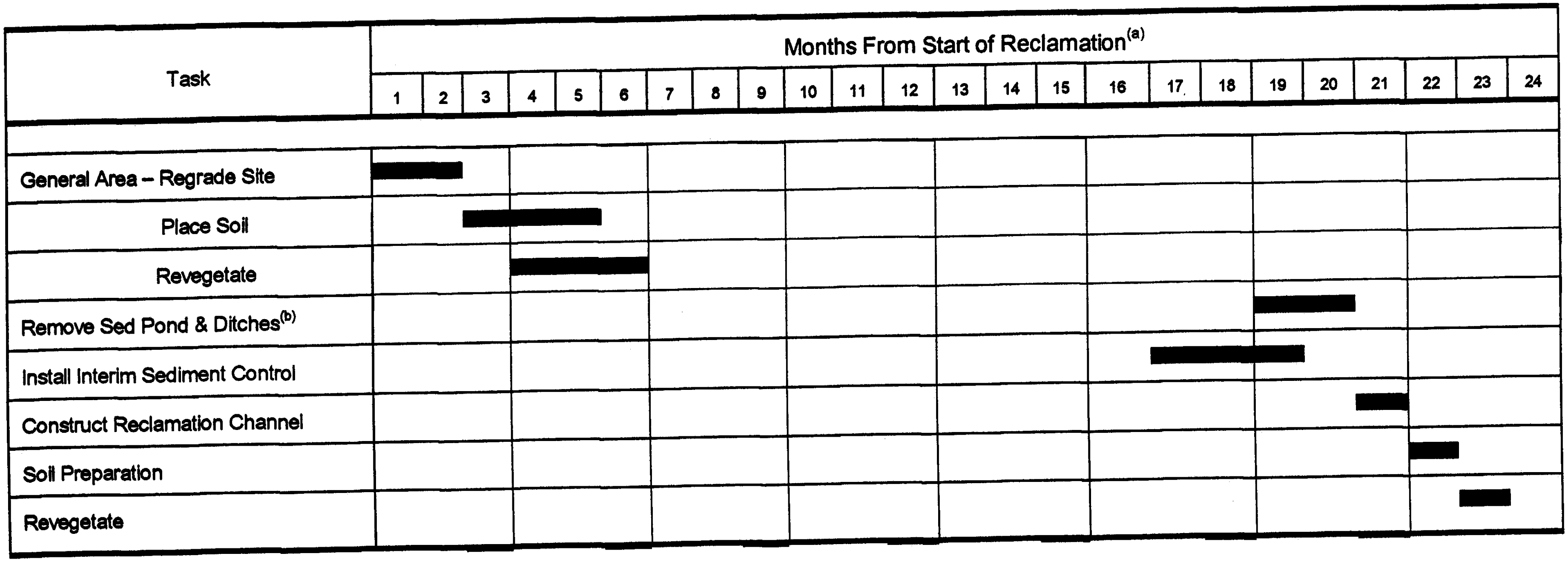
553.900 Regrading of Settled and Revegetated Fills

No settled or revegetated fills currently or will exist at the storage site.

560 PERFORMANCE STANDARDS

Coal mining and reclamation operations at the Dugout Canyon Mine will be conducted in accordance with the approved permit and the requirements of R645-301-510 through R645-301-553.

RA FIGURE 5-1
Reclamation Schedule



(a) Schedule assumes that weather conditions are conducive to reclamation activities

(b) Schedule will be based on success of the revegetation. If necessary, the timing can be extended.

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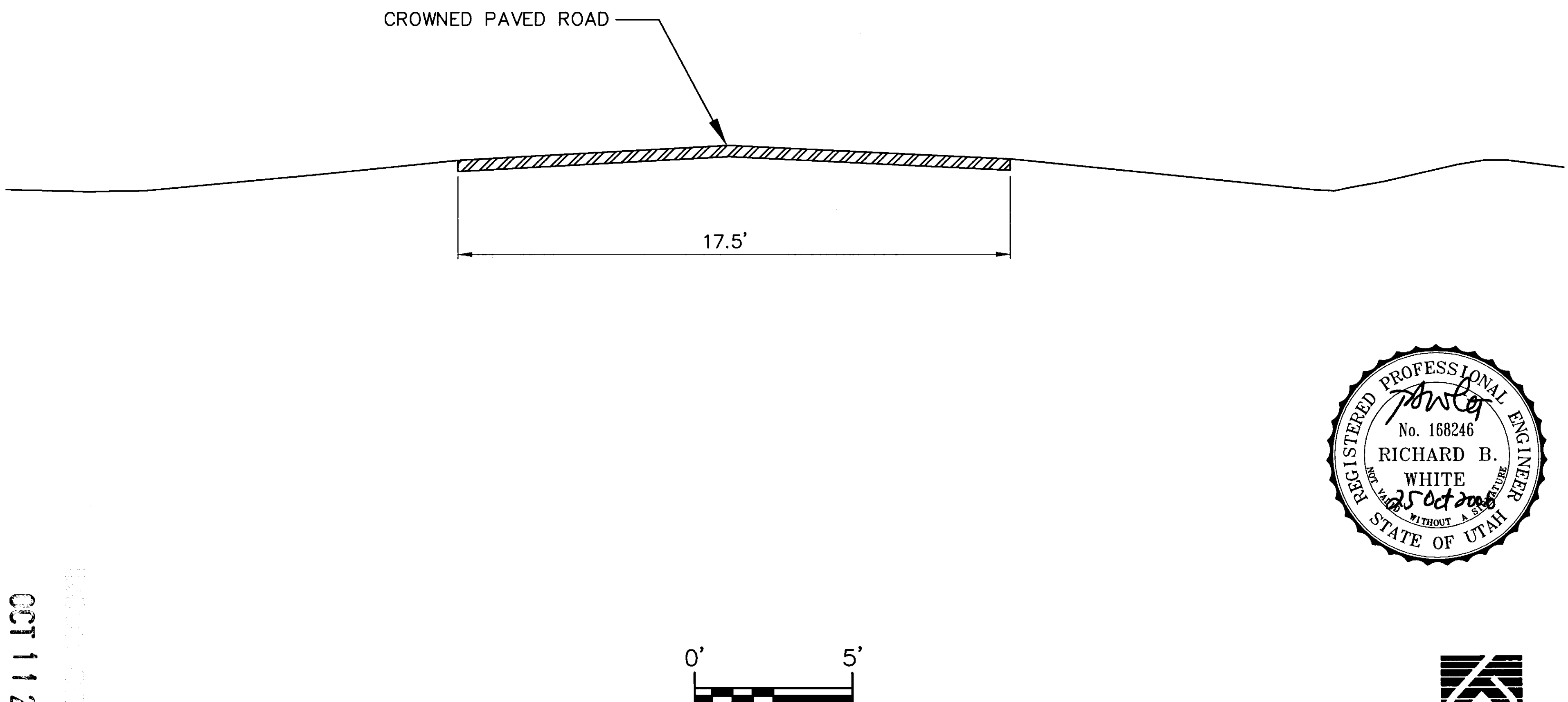

RA FIGURE 5-2. TYPICAL ACCESS ROAD CROSS-SECTION

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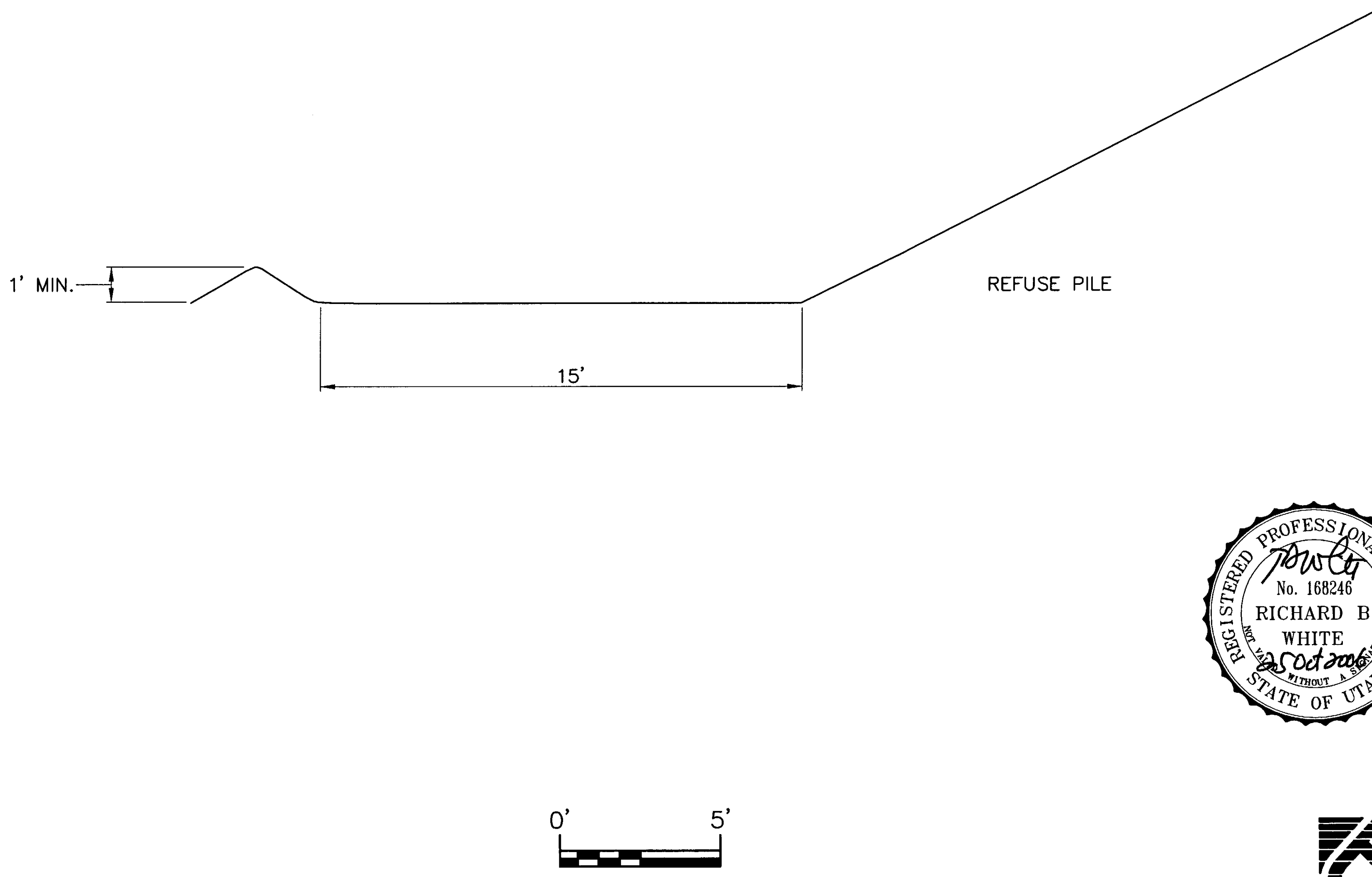

RA FIGURE 5-3. TYPICAL TEMPORARY ACCESS ROAD CROSS-SECTION

EarthFax

RA ATTACHMENT 5-1

SEDIMENT POND SLOPE STABILITY EVALUATION

RA ATTACHMENT 5-1

SEDIMENT POND SLOPE STABILITY EVALUATION

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May 21, 2001

Mr. Chris Hansen
Canyon Fuel Company, LLC
Dugout Canyon Mine
HC35 Box 380
Helper, Utah 84526

Subject: Results of slope stability analyses for the proposed sedimentation pond for the Dugout Canyon Mine

Dear Chris:

The purpose of this letter is to present the results of slope stability analyses for the proposed sedimentation pond for the Dugout Canyon Mine near Wellington, Utah. The proposed sedimentation pond is located about 4.5 miles southwest of the mine.

BACKGROUND INFORMATION

The site was originally investigated by RB&G Engineering, Inc. (1998; Provo, Utah) as a potential borrow source for granular fill used at the Dugout Canyon Mine. The results of that investigation indicated that the native soils consisted of interbedded layers of gravel and clay overlying Mancos Shale. Following removal and stockpiling of the topsoil, the underlying granular soils were excavated, crushed, screened, and transported to the Dugout Canyon Mine. The excavation typically continued downward until weathered Mancos Shale was encountered. As a result, the remaining soil at the site consisted primarily of thin layers of granular alluvium overlying weathered Mancos Shale and Mancos Shale bedrock.

The topography of the site following removal of the surficial granular soils and stockpiling of the topsoil is shown in Figure 1 (attached). As shown on Figure 1, the site has an irregular shape with most of the surface area present at the north end. Dugout Canyon Mine proposes to construct a waste-rock pile along the east-half of the north end of the site. Mine construction materials will be temporarily stockpiled at the west-half of the north end of the site. This area will also be used to pile snow removed from the working areas around the mine. A sedimentation pond to contain surface water runoff will be constructed at the south end of the site in a depression that was formed during removal of the surficial granular soils.

Based on preliminary design information, the inslope of the sedimentation pond embankment will be about 14 feet high and will slope 2 horizontal to 1 vertical (2H:1V). The embankment crest will be a minimum of 10 feet wide. The native slope will be used as the embankment outslope. In general, the top 26 feet of this native outslope slopes at about 21 degrees (2.6H:1V) (see Section A-A' in Figure 1). The lower portions of the native outslope flattens to about 11 degrees. The ponded water in the sedimentation pond will be a maximum of 11 feet deep, thereby leaving a freeboard of about 3 feet.

SOILS INFORMATION

As part of this investigation, EarthFax installed ten shallow test pits using a rubber tire backhoe. The locations of the test pits are presented in Figure 1 (attached). Test Pits DCW-1 through DCW-9 were excavated within the area from which granular alluvium was removed (see the previous section). Test Pits DCW-4 and DCW-5 were located within the footprint of the proposed sedimentation pond. Test Pit DCW-10 was installed to investigate the native outslope soils near the proposed sedimentation pond.

The test pits were logged by a geotechnical engineer from EarthFax and by a soil scientist from EIS, Inc. (Salt Lake City, Utah). EarthFax's test pit logs are attached. Nuclear density/moisture tests were conducted on the surface soils at most of the test pits to provide remolding criteria for samples submitted for direct shear tests. Select samples were submitted to Applied Geotechnical Engineering Consultants, Inc. (Sandy, Utah) for geotechnical laboratory analyses.

According to the test pit logs, a thin layer (2 to 2.2 feet thick) of weathered Mancos Shale over Mancos Shale bedrock was encountered at Test Pits DCW-3 and DCW-9. Remnants (2.7 to 9 feet thick) of gravelly sand alluvium were encountered at Test Pits DCW-1, DCW-2, DCW-4, and DCW-5. Mancos Shale bedrock was encountered below the alluvial soil at Test Pits DCW-1 and DCW-4. Test Pit DCW-6 contained layers of silty sand and sandy silt to a depth of 6 feet overlying gravelly sand to a depth of 7.5 feet. Test Pit DCW-7 encountered some coal, gravel, and soil to a depth of 0.7 feet, silty sand alluvium to a depth of 6 feet, and gravelly sand alluvium to a depth of about 7 feet. Stockpiled topsoil was encountered to a depth of 5 feet at Test Pit DCW-8, under which a gravelly sand alluvium extended to the bottom of the test pit at a depth of 6.5 feet.

Beyond the disturbed area at Test Pit DCW-10, the subsurface soils consisted of a silty sand topsoil to a depth of 1.1 feet over a gravelly sand layer to the bottom of the test pit at a depth of 8.5 feet.

Results of the laboratory analyses are attached and are summarized in Table 1. Direct shear tests were conducted on samples that were remolded to the same dry density and moisture contents that were recorded in the field from the nuclear density/moisture tests. According to the data in Table 1, the soil property parameters are as follows:

- **Weathered Mancos Shale (Test Pits DCW-3 and DCW-9):** The material contained 0 to 49% gravel, 15 to 16% sand, 25 to 61% silt, and 10 to 24% clay. According to the Atterberg Limits data, the liquid limit was 26 to 33, the plastic limit was 17 to 18, and the plastic index was 9 to 15. The angle of internal friction ranged between 33 and 37 degrees, and the cohesion intercept values ranged between 1320 and 1360 pounds per square foot ("psf"). The direct shear tests were conducted under consolidated, undrained, unsaturated (moist) conditions.

- **Gravelly Sand Alluvium (Test Pit DCW-1):** The material contained 52% gravel, 30% sand, and 18% silt. The angle of internal friction was 43 degrees and the soil was noncohesive from direct shear tests conducted under consolidated, undrained, unsaturated (moist) conditions.

- **Sandy Silt (Test Pit DCW-6):** The material contained 59% silt and 41% sand. The angle of internal friction was 45 degrees and the soil was noncohesive from direct shear tests conducted under consolidated, undrained, unsaturated (moist) conditions.

- **Native Soil Beyond the Disturbed Area (Test Pit DCW-10):** The material contained 34% gravel, 34% sand, and 32% silt. The angle of internal friction was 43 degrees and the cohesion intercept value was 210 psf from direct shear tests conducted under consolidated, undrained, unsaturated (moist) conditions.

ASSUMPTIONS

The following assumptions were made for the slope stability analyses:

1. As a worst-case condition, the native soil is vertically continuous and the failure surfaces do not intersect the Mancos Shale bedrock. This assumption was included because the Mancos Shale bedrock surface is variable throughout the site.

2. The native soils sampled and tested at Test Pit DCW-10 near the proposed sedimentation pond are representative of the moist embankment soils. Therefore, the soil property parameters in Table 1 (cohesive strength = 210 psf; angle of internal friction = 43 degrees) were used for the slope stability analyses.

3. The saturated strength of the native soil is two-thirds of the moist strength presented in the previous item in accordance with recommendations by Dunn et al. (1980).

4. The soils drain rapidly, and excess pore pressures do not develop in response to strains and stress changes.

5. The phreatic surface extends linearly from the full pond level to a level about 10 feet below the native soil surface for analyses conducted under saturated steady-state seepage conditions.

6. The pseudostatic seismic analysis assumes that the site will experience a peak horizontal acceleration of 0.18g (g is the acceleration of gravity), which has a 90% probability of not being exceeded in 50 years at the site (Algermissen et al., 1982).

RESULTS

Slope stability analyses were performed using the computer program GEOSLOPE (Version 5.0). GEOSLOPE utilizes the limit equilibrium procedure of slices (Simplified Bishop's method) to determine the safety factor of potential failure surfaces for circular shapes.

Using the assumptions presented above, results of the slope stability analyses are attached and are summarized in Table 2 (attached). The results of the stability analyses include the data files and the output files. Table 2 includes a description of the analysis slope, the number of trial failure surfaces, and the critical safety factor against sliding. From Table 2, the results are as follows:

- **Outslope with Full Pond and No Phreatic Surface:** This condition assumes that the water level in the pond is 3 feet below the embankment crest, but the embankment is not saturated. The critical safety factor was 3.5.

- **Outslope with Full Pond and Phreatic Surface (Steady-State Seepage):** This condition assumes that the water level in the pond is 3 feet below the embankment crest, and that a phreatic surface develops that extends linearly to a level about 10 feet below the native soil surface, thereby creating a steady-state seepage condition wherein the deeper native soils become saturated. The critical safety factor was 1.9, which satisfies the minimum regulatory requirement of 1.3 promulgated by the Utah Division of Oil, Gas, and Mining (R645-301-533.100).

- **Steady-State Seepage with Seismic Loading:** This condition includes the steady-state seepage condition described in the previous item with a peak horizontal acceleration of 0.18g applied to the embankment for a pseudostatic seismic analysis. The critical safety factor was 1.23.

- **Inslope with Rapid Drawdown:** This condition assumes that the water level in the pond was 3 feet below the embankment crest, that a phreatic surface developed that extended linearly to a level about 10 feet below the native soil surface, and that the pond then drained rapidly. The critical safety factor was 2.2.

We have appreciated the opportunity to provide this information. If you have any questions, please call.

Sincerely,

RHETT BROOKS

Rhett Brooks, P.E.
EarthFax Engineering, Inc.

cc: Tom Suchoski, EarthFax

REGISTERED PROFESSIONAL ENGINEER
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RHETT K.
BROOKS
STATE OF UTAH

RHETT BROOKS
MAY 21, 2001

REFERENCES

Algermissen, S., D. Perking, P. Thenhaus, S. Hanson, and B. Bender, 1982. Probabilistic Estimates of Maximum Acceleration and Velocity in Rock in the Contiguous United States. U.S. Geological Survey Open-File Report 82-1033.

Dunn, I.S., L.R. Anderson, and F.W. Kiefer. Fundamentals of Geotechnical Analysis. John Wiley & Sons, New York, New York.

Utah Division of Oil, Gas, and Mining. 1996. Utah Coal Mining Regulations. Salt Lake City, Utah.

TABLE 1

SUMMARY OF LABORATORY TEST RESULTS

Test Pit and Depth (Ft.)	Gradation (%)				Atterberg Limits			Direct Shear Test Values	
	Gravel	Sand	Silt	Clay	Liquid Limit	Plastic Index	Plastic Limit	Cohesive Strength (psf)	Angle of Internal Friction (degrees)
DCW-1 0-3.2[a]	52	30	18		--	--	--	0	43
DCW-3 0-2.2[b]	49	16	25	10	33	15	18	1320	37
DCW-6 2.5-6[c]	0	41	59		--	--	--	0	45
DCW-9 0-1.2[d]	0	15	61	24	26	9	17	1360	33
DCW-10 1.1-8.5[e]	34	34	32		--	--	--	210	43

(a) Alluvium. Sample for direct shear test remolded to a dry density of 115 pcf at a moisture content of 6%, which were the results of a nuclear density/moisture test conducted on the ground surface near the test pit. Direct shear test conducted under consolidated-undrained (CU) unsaturated conditions with vertical effective pressures of 1200, 3600, and 6000 psf.

(b) Weathered Mancos Shale. Direct shear test samples remolded to a dry density of 113 pcf at a moisture content of 6%, which were the results of a nuclear tests conducted on the ground surface near the test pit. Direct shear test conducted under consolidated-undrained (CU) unsaturated conditions with vertical effective pressures of 1200, 3600, and 6000 psf.

(c) Silty sand. Sample for direct shear test remolded to a dry density of 112 pcf at a moisture content of 9%, which were the results of a nuclear density/moisture test conducted on the ground surface near the test pit. Direct shear test conducted under consolidated-undrained (CU) unsaturated conditions with vertical effective pressures of 1200, 3600, and 6000 psf.

(d) Weathered Mancos Shale. Direct shear test samples remolded to a dry density of 98 pcf at a moisture content of 6%, which were the results of a nuclear test conducted on the ground surface near the test pit. Direct shear test conducted under consolidated-undrained (CU) unsaturated conditions with vertical effective pressures of 1200, 3600, and 6000 psf.

(e) Silty Sand. Direct shear test samples remolded to a dry density of 100 pcf at a moisture content of 8%, which were the results of a nuclear test conducted on the ground surface near the test pit. Direct shear test conducted under consolidated-undrained (CU) unsaturated conditions with vertical effective pressures of 500, 1500, and 2500 psf.

TABLE 2

RESULTS OF SLOPE STABILITY ANALYSES

Condition	Number of Trial Failure Surfaces	Safety Factor
Outslope with Full Pond and No Phreatic Surface	3600	3.5
Outslope with Full Pond and Phreatic Surface (Steady-State Seepage)	3600	1.9
Steady-State Seepage with Seismic Loading	3600	1.23
Inslope with Rapid Drawdown	2700	2.2

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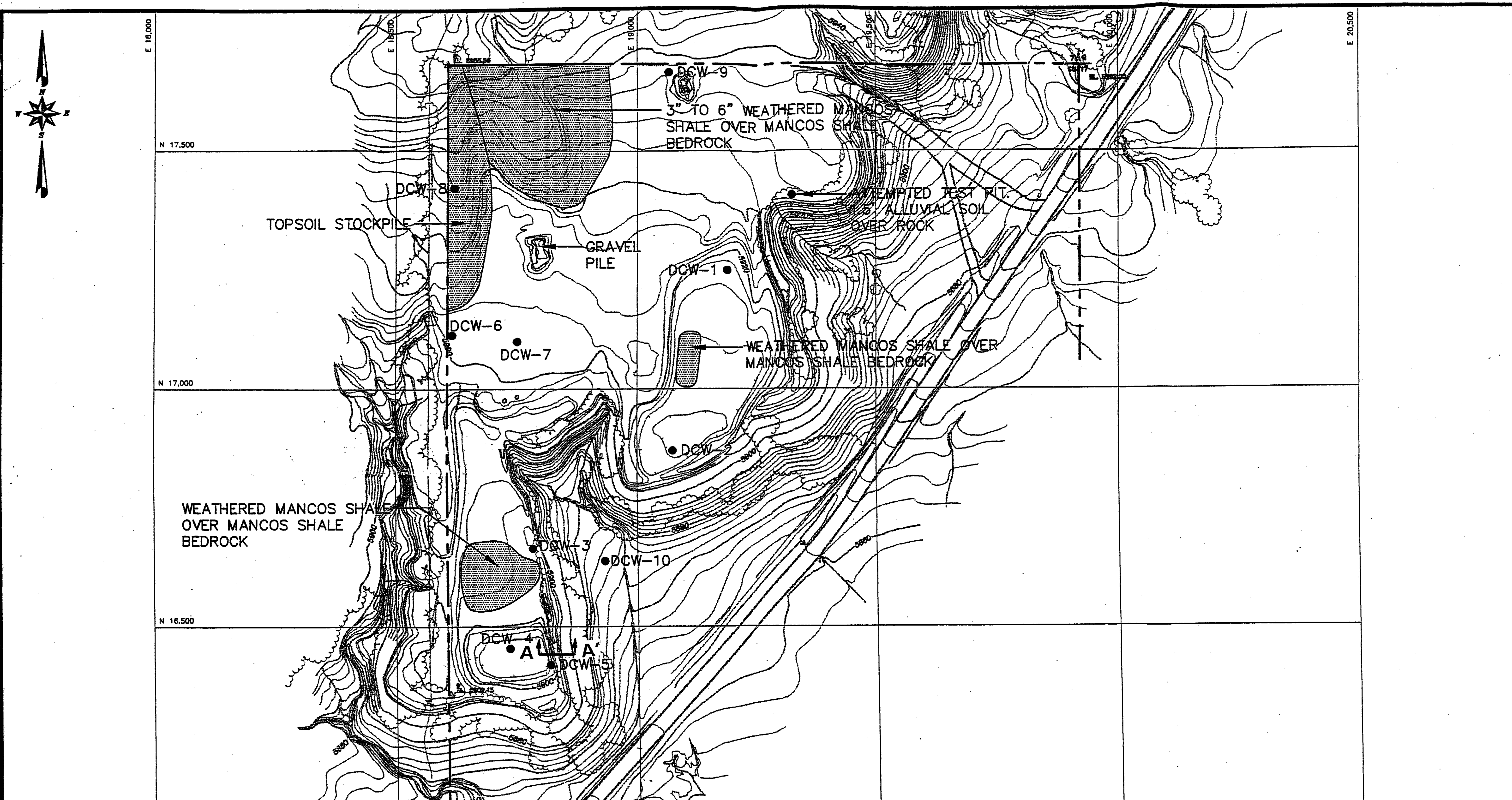


LEGEND

DCW-1
● TEST PIT LOCATION

0' 200'

EarthFax

FIGURE 1. TEST PIT LOCATIONS

TEST PIT DCW-1
(Excavated and logged on September 16, 1999)

Depth (ft.)	Description
0 - 3.2	Sandy Gravel w/ Silt and Cobbles. Alluvium. About 42% gravel, 30% sand, 10% cobbles, and 18% silt. Sand is typically fine to coarse grained. Cobbles are up to 7 inches in diameter, subround. Gravel is subround to subangular. Moist. No cementation or cohesion. Good foundation material or fill material. From a 12-inch nuclear density/moisture test: moisture content = 5.7%, dry density = 115.5 pounds per cubic foot, wet density = 122.1 pounds per cubic foot. Brown 10YR 4/3. GM.
3.2 - 4.6	Mancos Shale Bedrock. Fractured. Gray. Hard to dig.

TEST PIT DCW-2
(Excavated and logged on September 16, 1999)

Depth (ft.)	Description
0 - 7.7	Gravelly Sand w/ Silt, Cobbles, and Boulders. Alluvium. About 45% sand, 25% gravel, 15% cobbles/boulders, and 15% silt. Sand is typically fine to coarse grained. Gravel is subround to subangular. Moist. No cementation or cohesion. Good foundation material or fill material. From a 8-inch nuclear density/moisture test: moisture content = 7.8%, dry density = 115.0 pounds per cubic foot, wet density = 124.0 pounds per cubic foot. Brown 10YR 4/3. Boulders at bottom impeded digging deeper. SM.

TEST PIT DCW-3
(Excavated and logged on September 16, 1999)

Depth (ft.)	Description
0 - 2.2	Weathered Mancos Shale. 49% gravel (fractured Mancos Shale), 16% sand, 25% silt, and 10% clay. Loose in top 3 inches, firmer and less weathered with depth. From a 12-inch nuclear density/moisture test: moisture content = 5.6%, dry density = 112.6 pounds per cubic foot, wet density = 118.8 pounds per cubic foot.
2.2 - 3.2	Mancos Shale Bedrock. Fractured and slightly weathered. Gray. Hard to dig.

TEST PIT DCW-4
(Excavated and logged on September 16, 1999)

Depth (ft.)	Description
0 - 2.7	Gravelly Sand w/ Silt. Alluvium. About 55% sand, 20% gravel, 10% cobbles, and 15% silt. Sand is typically fine to coarse grained. Cobbles are up to 7 inches in diameter, subround. Gravel is subround to subangular. Moist. No cementation or cohesion. Good foundation material or fill material. From a 12-inch nuclear density/moisture test: moisture content = 5.7%, dry density = 115.5 pounds per cubic foot, wet density = 122.1 pounds per cubic foot. Brown 10YR 4/3. SM.
2.7 - 3.2	Mancos Shale Bedrock. Fractured. Gray. Hard to dig.

TEST PIT DCW-5
(Excavated and logged on September 16, 1999)

Depth (ft.)	Description
0 - 9	Gravelly Sand w/ Silt. Alluvium. About 55% sand, 20% gravel, 10% cobbles, and 15% silt. Sand is typically fine to coarse grained. Cobbles are up to 7 inches in diameter, subround. Gravel is subround to subangular. Moist. No cementation or cohesion. Good foundation material or fill material. From a 12-inch nuclear density/moisture test: moisture content = 5.7%, dry density = 115.5 pounds per cubic foot, wet density = 122.1 pounds per cubic foot. Brown 10YR 4/3. SM.

TEST PIT DCW-6
(Excavated and logged on September 16, 1999)

Depth (ft.)	Description
0 - 1.5	Silty Sand. About 60% sand and 40% silt. Sand is very fine to fine grained. Nonplastic. Numerous large roots from pine trees. From a 12-inch nuclear density/moisture test: moisture content = 8.8%, dry density = 102.9 pounds per cubic foot, wet density = 111.9 pounds per cubic foot. Yellowish brown 10YR 5/4. SM.
1.5 - 2.5	Sandy Silt. About 65% silt and 35% silt. Sand is very fine grained. Low plasticity, somewhat cohesive. Dry and hard. Very friable. ML.
2.5 - 6	Sandy Silt. About 59% silt and 41% sand. Sand is very fine grained. Nonplastic. Probably a blow sand layer. Light yellowish brown 2.5Y 6/3. ML.
6 - 7.5	Gravelly Sand w/ Silt. Alluvium. About 55% sand, 20% gravel, 10% cobbles/boulders, and 15% silt. Sand is typically fine to coarse grained. Gravel is subround to subangular. Moist. No cementation or cohesion. Brown 10YR 4/3. SM.

TEST PIT DCW-7
(Excavated and logged on September 16, 1999)

Depth (ft.)	Description
0 - 0.7	Mix of Rubbish. Mix of coal, sandstone, and dark brown soil (silt through cobbles). SM.
0.7 - 6	Silty Sand w/ Gravel. Alluvium. About 70% sand, 10% gravel/cobbles, 20% silt. Sand is typically fine to coarse grained. Gravel is subround to subangular. Moist. No cementation or cohesion. Brown 10YR 4/3. SM.
6 - 7	Gravelly Sand w/ Silt. Alluvium. About 55% sand, 20% gravel, 10% cobbles, and 15% silt. Sand is typically fine to coarse grained. Gravel is subround to subangular. Moist. No cementation or cohesion. Brown 10YR 4/3. SM.

TEST PIT DCW-8
Topsoil Stockpile
(Excavated and logged on September 16, 1999)

Depth (ft.)	Description
0 - 5	Topsoil Stockpile. Topsoil that had been stripped from the site and piled in this area. Primarily silty sand with gravel and organic matter.
5 - 6.5	Gravelly Sand w/ Silt. Alluvium. About 55% sand, 20% gravel, 10% cobbles, and 15% silt. Sand is typically fine to coarse grained. Gravel is subround to subangular. Moist. No cementation or cohesion. Brown 10YR 4/3. SM.

TEST PIT DCW-9
(Excavated and logged on September 16, 1999)

Depth (ft.)	Description
0 - 2	Weathered Mancos Shale. 61% silt, 24% clay, and 15% sand. Loose in top 14 inches, firmer and less weathered with depth. From a 12-inch nuclear density/moisture test: moisture content = 5.7%, dry density = 98.3 pounds per cubic foot, wet density = 103.8 pounds per cubic foot. CL.
2 - 2.5	Mancos Shale Bedrock. Fractured and slightly weathered. Gray. Hard to dig.

TEST PIT DCW-10
Near Proposed Sedimentation Pond Embankment
(Excavated and logged on September 16, 1999)

Depth (ft.)	Description
0 - 1.1	Silty Sand Topsoil. About 75% sand and 25% silt. Sand is very fine to fine grained. Nonplastic. Numerous fine roots. From a 12-inch nuclear density/moisture test: moisture content = 8.2%, dry density = 95.9 pounds per cubic foot, wet density = 103.7 pounds per cubic foot. Brown 10YR 4/3. SM.
1.1 - 8.5	Gravelly Sand w/ Silt. Alluvium. About 34% sand, 34% gravel/cobbles, and 32% silt. Sand is typically fine to coarse grained. Gravel is subround to subangular. Moist. No cementation or cohesion. Brown 10YR 4/3. SM.

Applied Geotechnical Engineering Consultants, Inc.

October 19, 1999

Earthfax Engineering
7324 South 1300 East, Suite 100
Midvale, UT 84047

Attention: Rhett Brooks

Subject: Soil Testing for Waste Rock Pile Foundation Investigation
Dugout Canyon, Utah
AGEC Project No. 1990648

Gentlemen:

Applied Geotechnical Engineering Consultants, Inc. was requested to provide laboratory testing on five bucket samples delivered to our laboratory September 17, 1999. The following tests were performed in general accordance with the test methods listed.

Test	Test Method
Particle Size Analysis	ASTM D 422
Atterberg Limits	ASTM D 4318
Direct Shear	ASTM D 3080

The results of the laboratory testing are summarized in Table I and shown graphically in Figures 1 through 8.

If you have any questions, or if we can be of further service, please call.

Sincerely,

APPLIED GEOTECHNICAL ENGINEERING CONSULTANTS, INC.

Stephanie Merkley

Stephanie Merkley

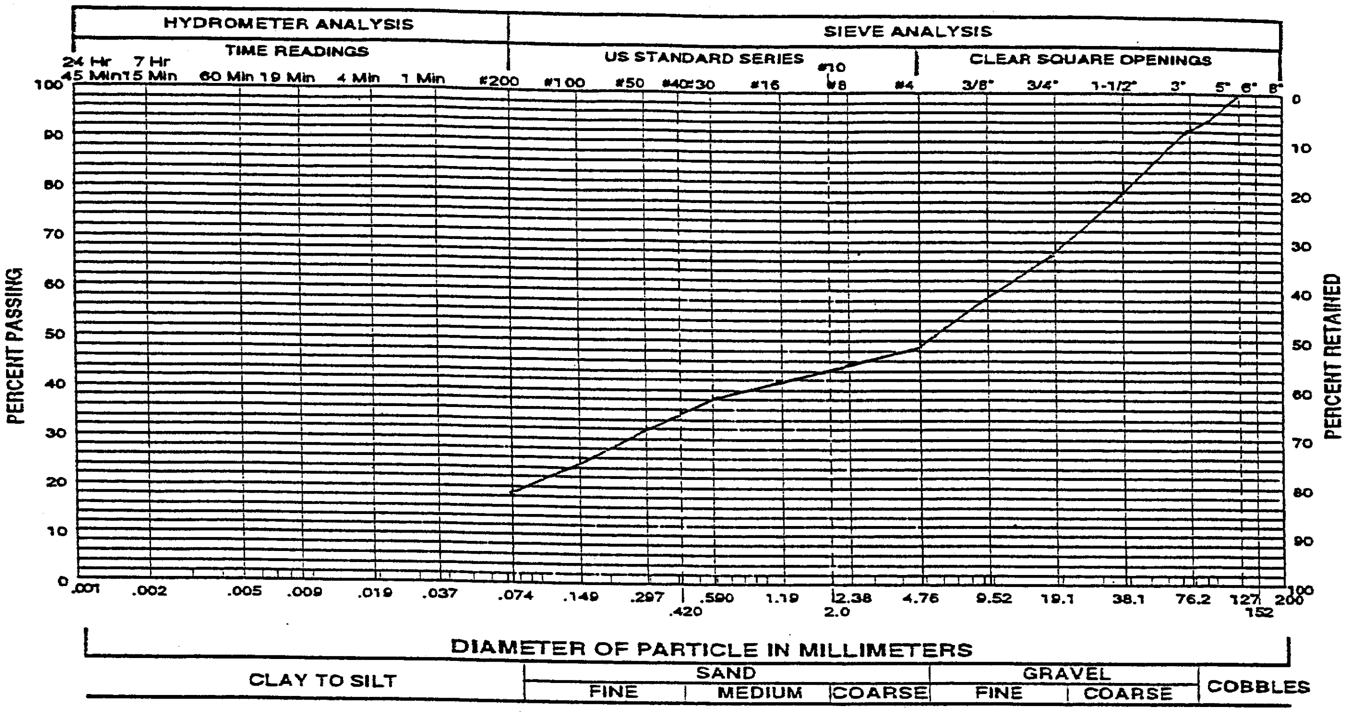
Reviewed by SDA, E.I.T.

APPLIED GEOTECHNICAL ENGINEERING CONSULTANTS, INC.

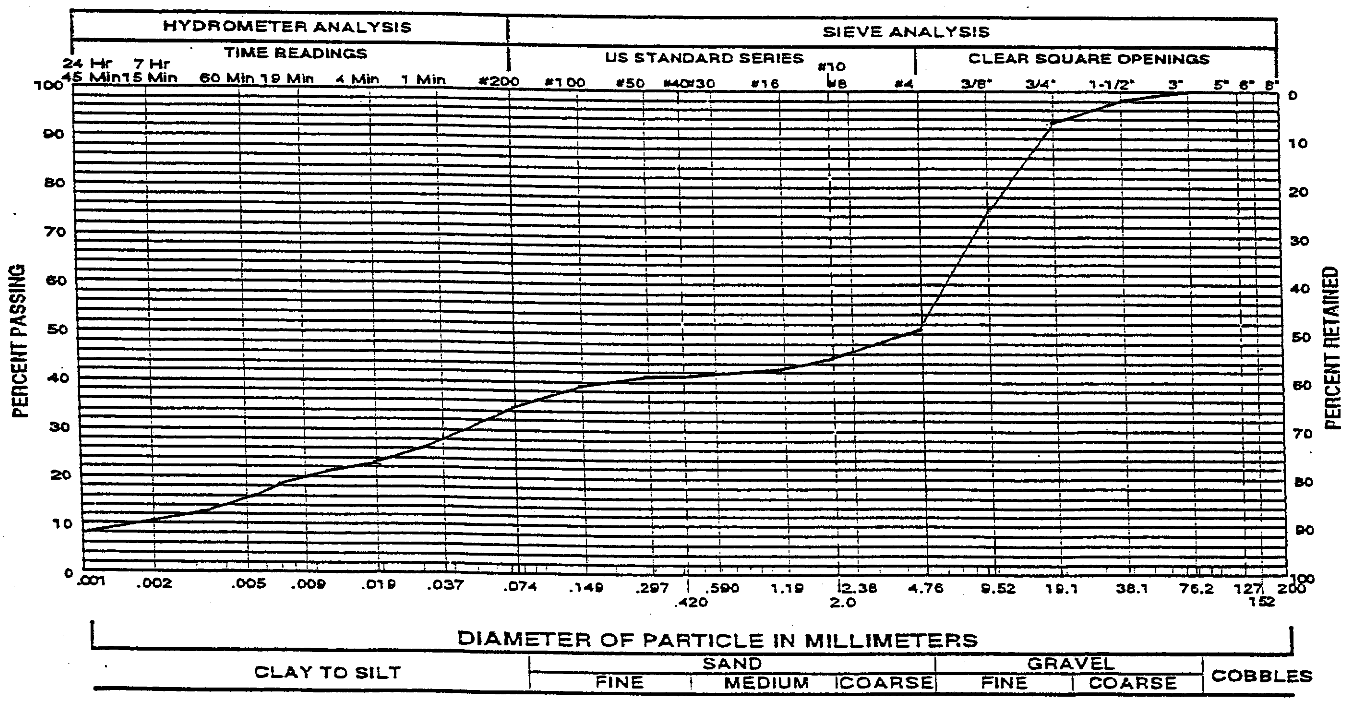
Table I. Summary of Laboratory Results

Sample Location	Gradation			Atterberg Limits		Sample Classification
	Gravel (%)	Sand (%)	Silt/ Clay (%)	Liquid Limit (%)	Plasticity Index (%)	
DCW-1 @ 0"-38"	52	30	18			Silty Gravel with Sand (GM)
DCW-3 @ 0"-26"	49	16	35	33	15	Clayey Gravel with Sand (GC)
DCW-6 @ 2.5'-6'	0	41	59			Sandy Silt (ML)
DCW-9 @ 0"-14"	0	15	85	26	9	Lean Clay with Sand (CL)
DCW-10 @ 13"-102"	34	34	32			Silty Sand with Gravel (SM)

Applied Geotechnical Engineering Consultants, Inc.



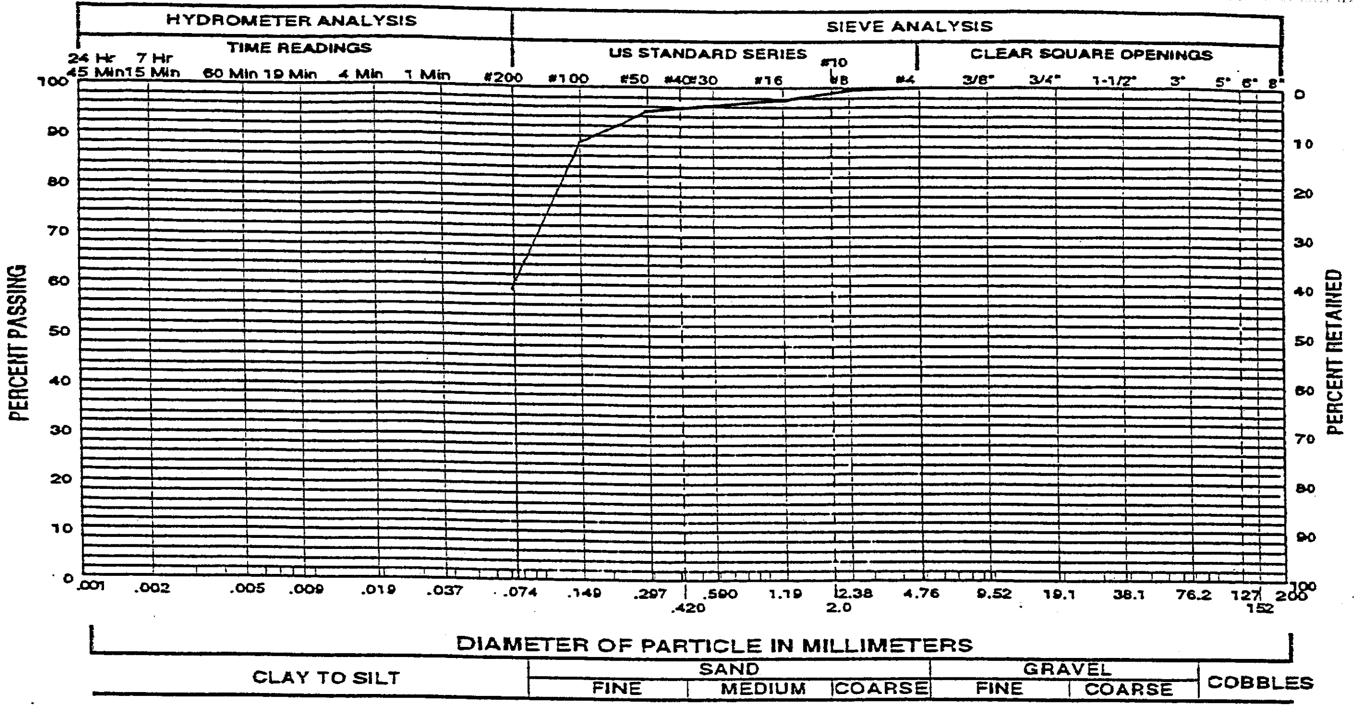
Gravel 52 % Sand 30 % Silt and Clay 18 %
Liquid Limit ______ % Plasticity Index ______ %
Sample of Silty Gravel with Sand (GM) From Test Pit DCW-1 @ 0"-38"



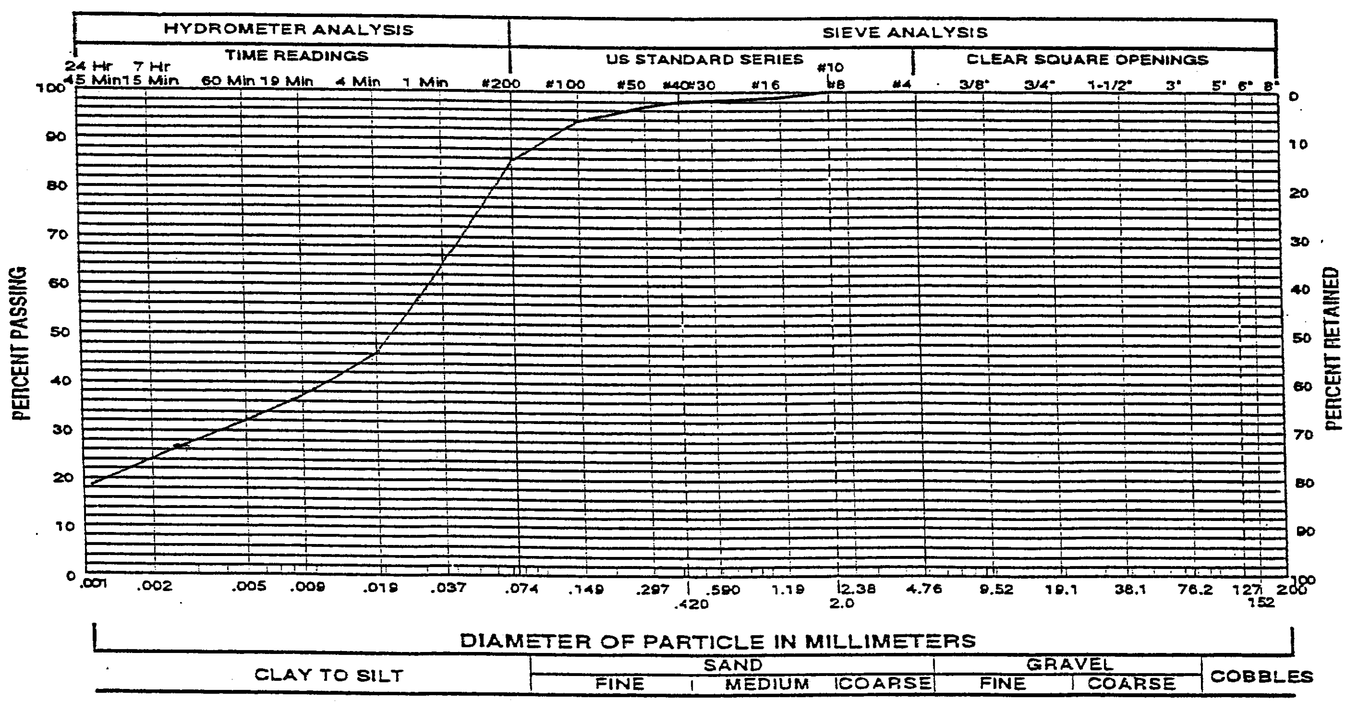
Gravel 49 % Sand 16 % Silt and Clay 35 %
Liquid Limit 33 % Plasticity Index 15 %
Sample of Clayey Gravel with Sand (GC) From Test Pit DCW-3 @ 0"-26"

Project No. 1990648 **GRADATION TEST RESULTS** Figure 1

Applied Geotechnical Engineering Consultants, Inc.



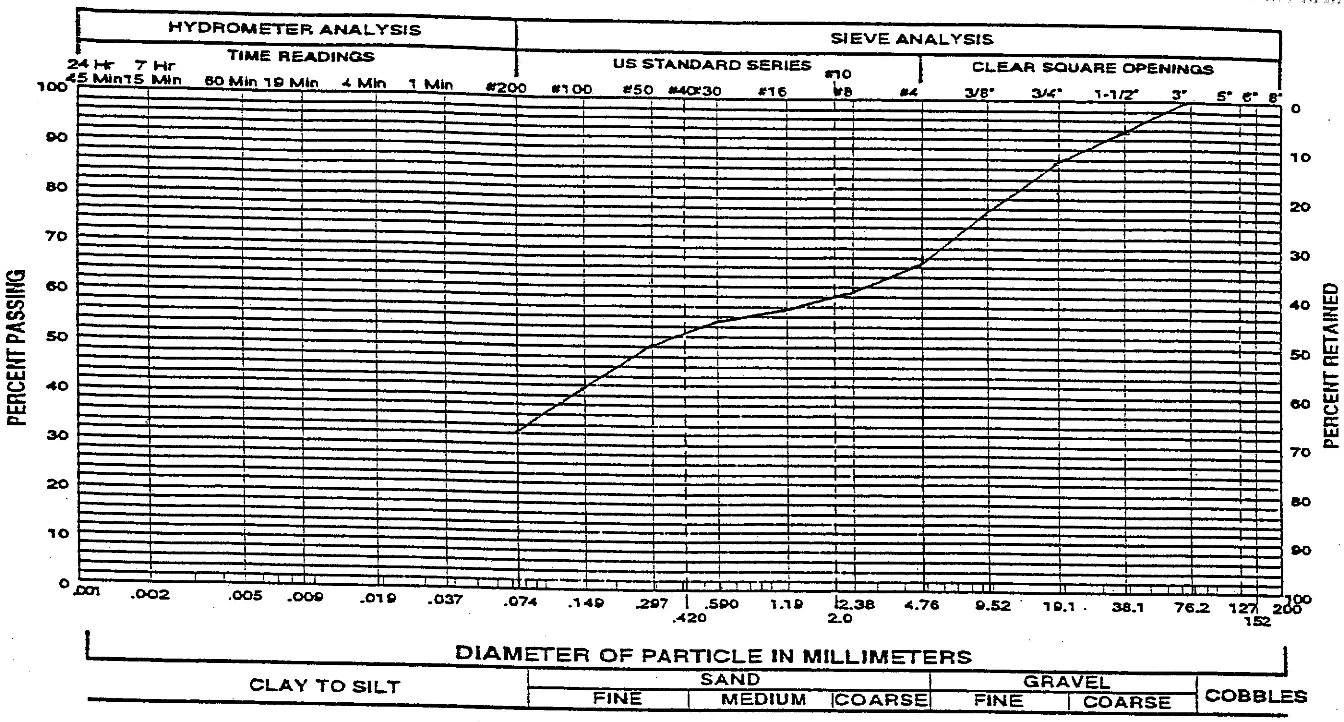
Gravel 0 % Sand 41 % Silt and Clay 59 %
Liquid Limit ___ % Plasticity Index ___ %
Sample of Sandy Silt (ML) From Test Pit DCW-6 @ 2.5'-6'



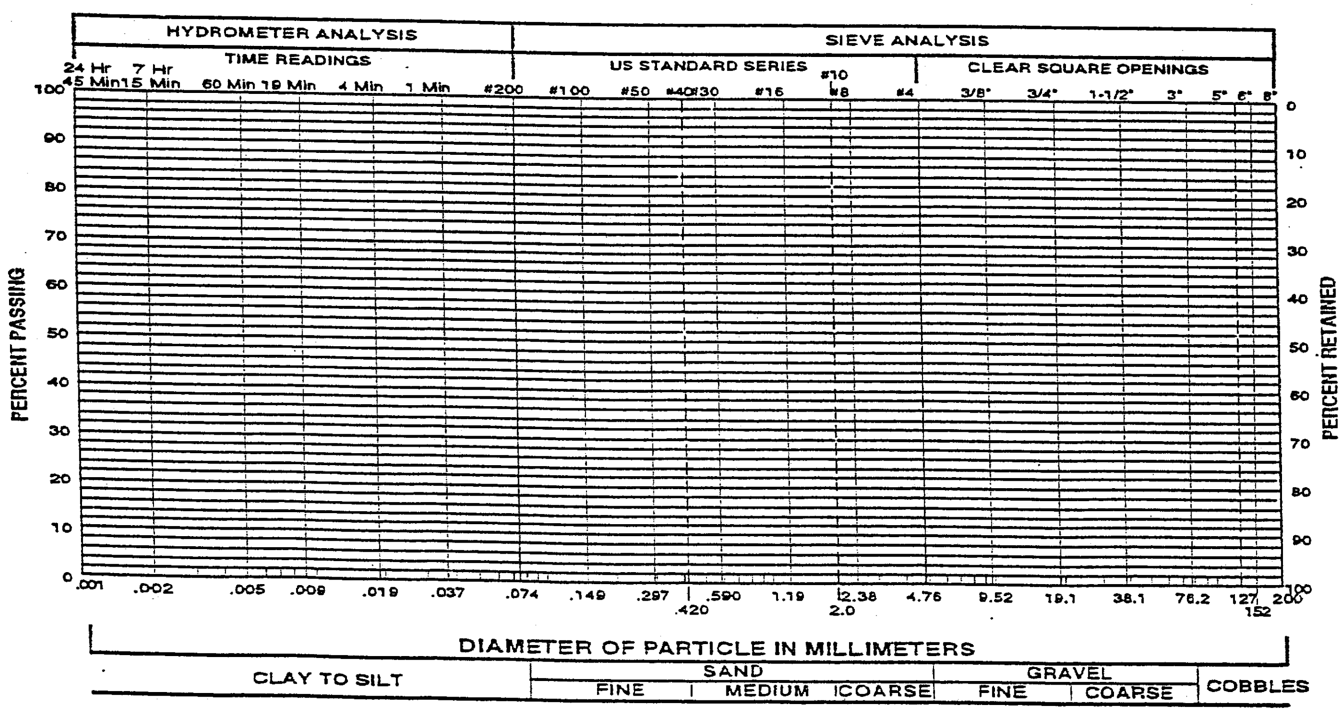
Gravel 0 % Sand 15 % Silt and Clay 85 %
Liquid Limit 26 % Plasticity Index 9 %
Sample of Lean Clay with Sand (CL) From Test Pit DCW-9 @ 0"-14"

Project No. 1990648 **GRADATION TEST RESULTS** Figure 2

Applied Geotechnical Engineering Consultants, Inc.



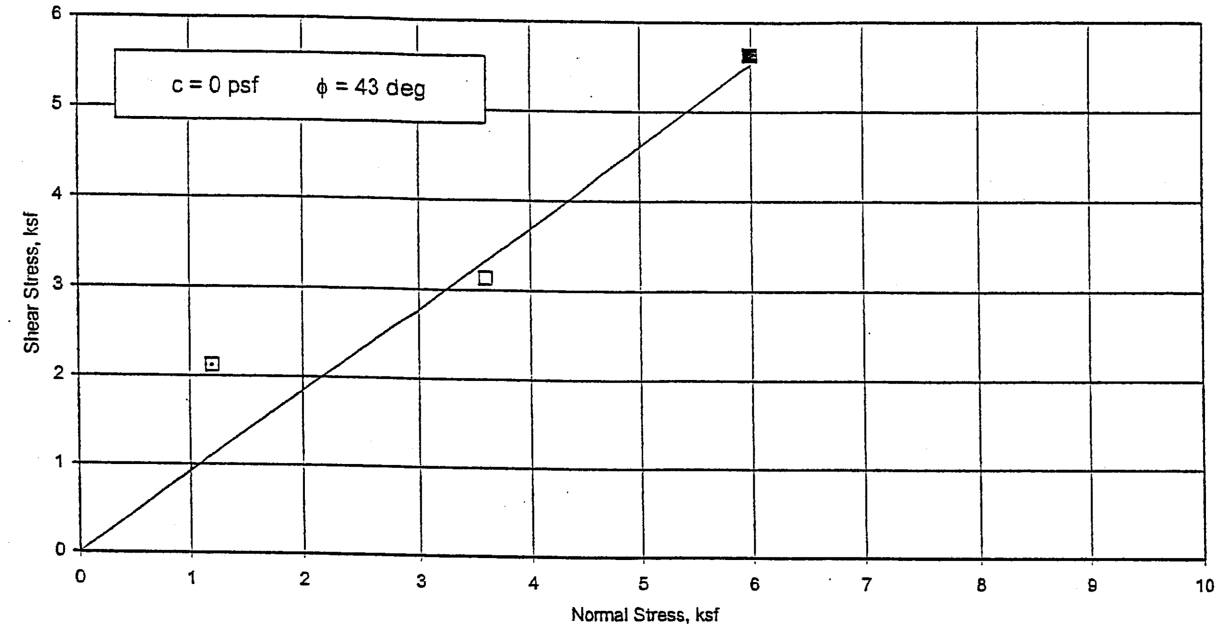
Gravel 34 % Sand 34 % Silt and Clay 32 %
Liquid Limit ______ % Plasticity Index ______ %
Sample of Silty Sand with Gravel (SM) From Test Pit DCW-10 @ 13"-102"

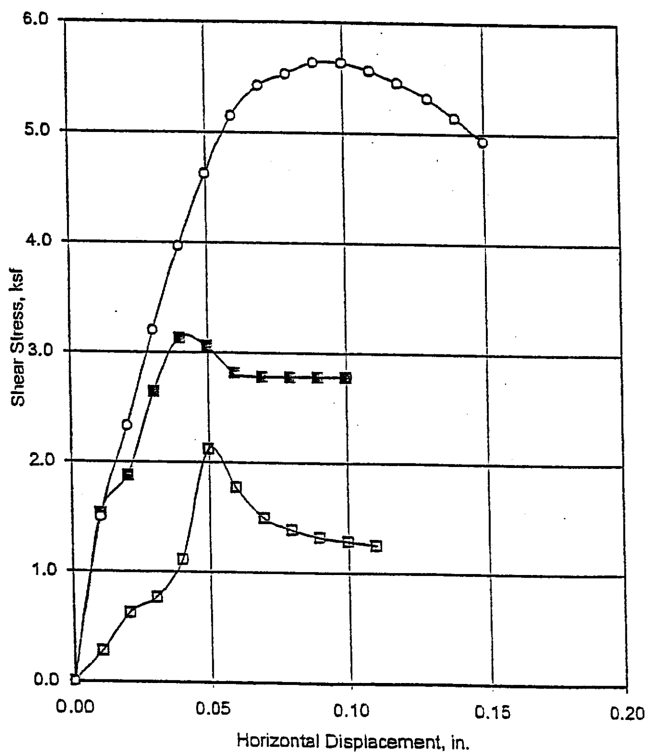


Gravel ______ % Sand ______ % Silt and Clay ______ %
Liquid Limit ______ % Plasticity Index ______ %
Sample of ______ From ______

Project No. 1990648 **GRADATION TEST RESULTS** Figure 3

Applied Geotechnical Engineering Consultants, Inc.





Test No. (Symbol)	1(□)	2(■)	3(○)
Sample Type	Remolded		
Length, in.	1.00	1.00	1.00
Diameter, in.	1.93	1.93	1.93
Dry Density, pcf	115	115	115
Moisture Content, %	6	6	6
Consolidation Load, ksf	1.2	3.6	6.0
Normal Load, ksf	1.2	3.6	6.0
Shear Stress, ksf	2.12	3.13	5.64
Remarks	Strain Rate 0.05 in/min. Test performed on material passing the No. 4 sieve.		

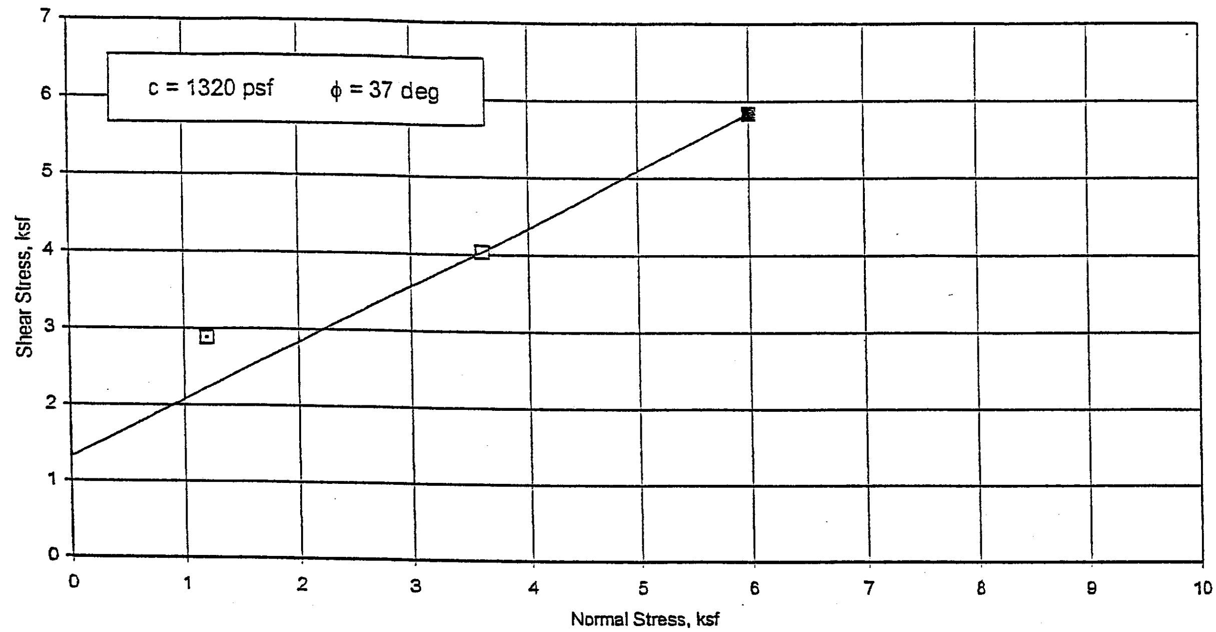
Sample Index Properties	
Dry Density, pcf	N/A
Moisture Content, %	N/A
Liquid Limit, %	N/A
Plasticity Index, %	N/A
Percent Gravel	52
Percent Sand	30
Percent Passing No. 200 Sieve	18

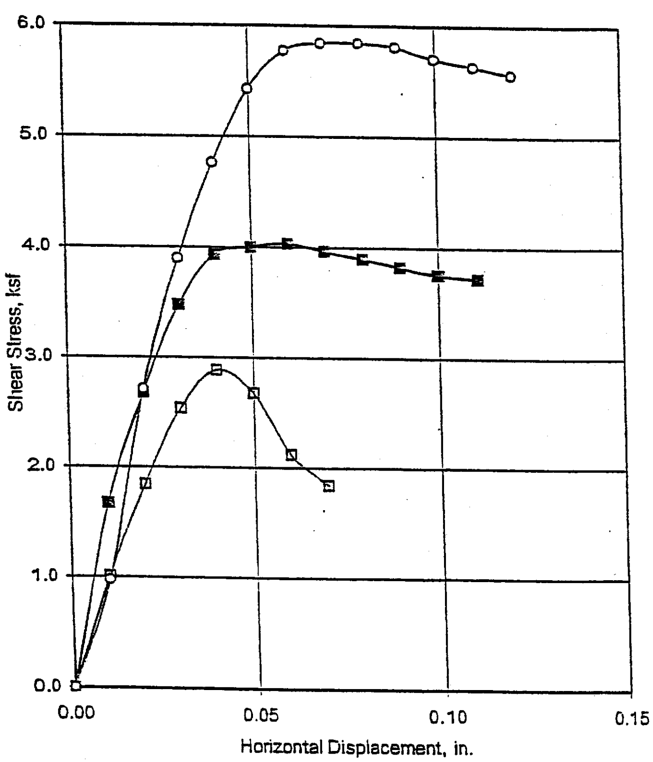
Type of Test: Consolidated Undrained/Unsaturated

Sample Description: Silty Gravel with Sand (GM)   From: Test Pit DCW-1 @ 0"-38"

Project No. 1990648   **DIRECT SHEAR TEST RESULTS**   Figure 4

Applied Geotechnical Engineering Consultants, Inc.





Test No. (Symbol)	1(□)	2(■)	3(O)
Sample Type	Remolded		
Length, in.	1.00	1.00	1.00
Diameter, in.	1.93	1.93	1.93
Dry Density, pcf	113	113	113
Moisture Content, %	6	6	6
Consolidation Load, ksf	1.2	3.6	6.0
Normal Load, ksf	1.2	3.6	6.0
Shear Stress, ksf	2.89	4.04	5.85
Remarks	Strain Rate 0.05 in/min. Test performed on material passing the No. 4 sieve.		

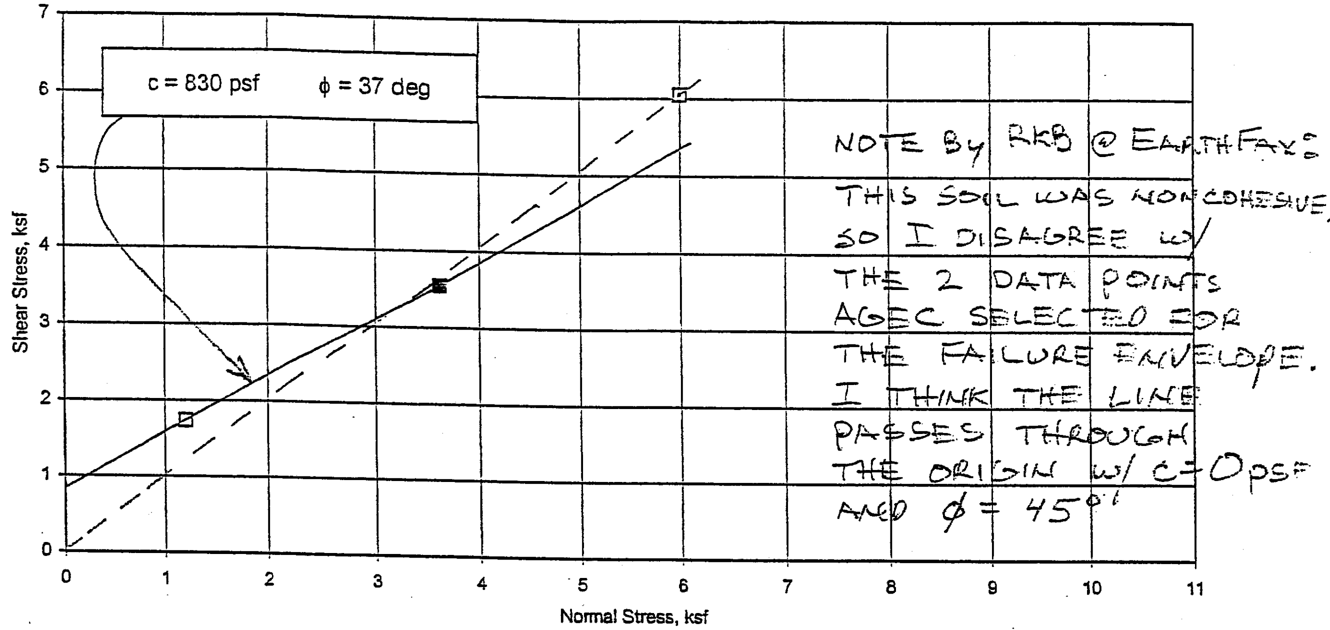
Sample Index Properties	
Dry Density, pcf	N/A
Moisture Content, %	N/A
Liquid Limit, %	33
Plasticity Index, %	15
Percent Gravel	49
Percent Sand	16
Percent Passing No. 200 Sieve	35

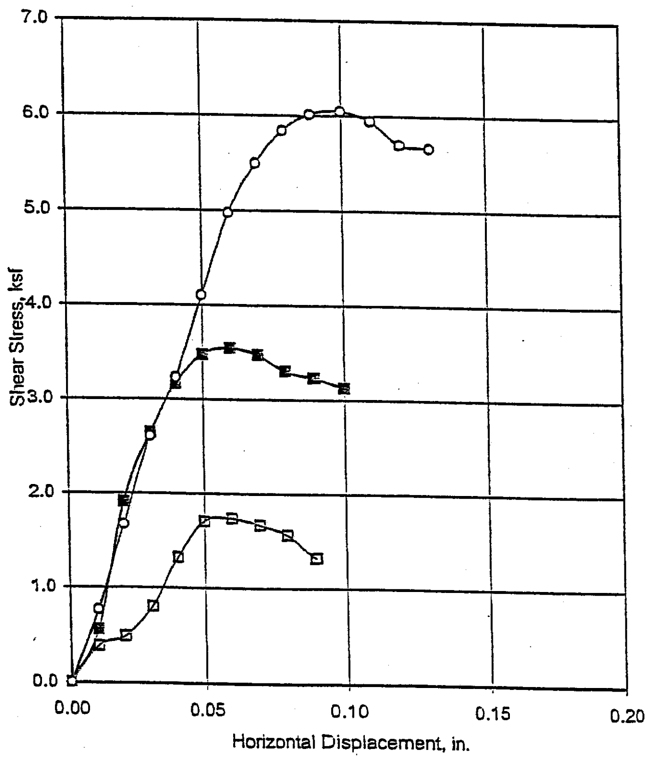
Type of Test: Consolidated Undrained/Unsaturated

Sample Description: Clayey Gravel with Sand (GC)   From: Test Pit DCW-3 @ 0"-26"

Project No. 1990648   **DIRECT SHEAR TEST RESULTS**   Figure 5

Applied Geotechnical Engineering Consultants, Inc.





Test No. (Symbol)	1(□)	2(■)	3(O)
Sample Type	Remolded		
Length, in.	1.00	1.00	1.00
Diameter, in.	1.93	1.93	1.93
Dry Density, pcf	112	112	112
Moisture Content, %	9	9	9
Consolidation Load, ksf	1.2	3.6	6.0
Normal Load, ksf	1.2	3.6	6.0
Shear Stress, ksf	1.74	3.55	6.05
Remarks	Strain Rate 0.05 in/min. Test performed on material passing the No. 4 sieve.		

Sample Index Properties	
Dry Density, pcf	N/A
Moisture Content, %	N/A
Liquid Limit, %	N/A
Plasticity Index, %	N/A
Percent Gravel	0
Percent Sand	41
Percent Passing No. 200 Sieve	59

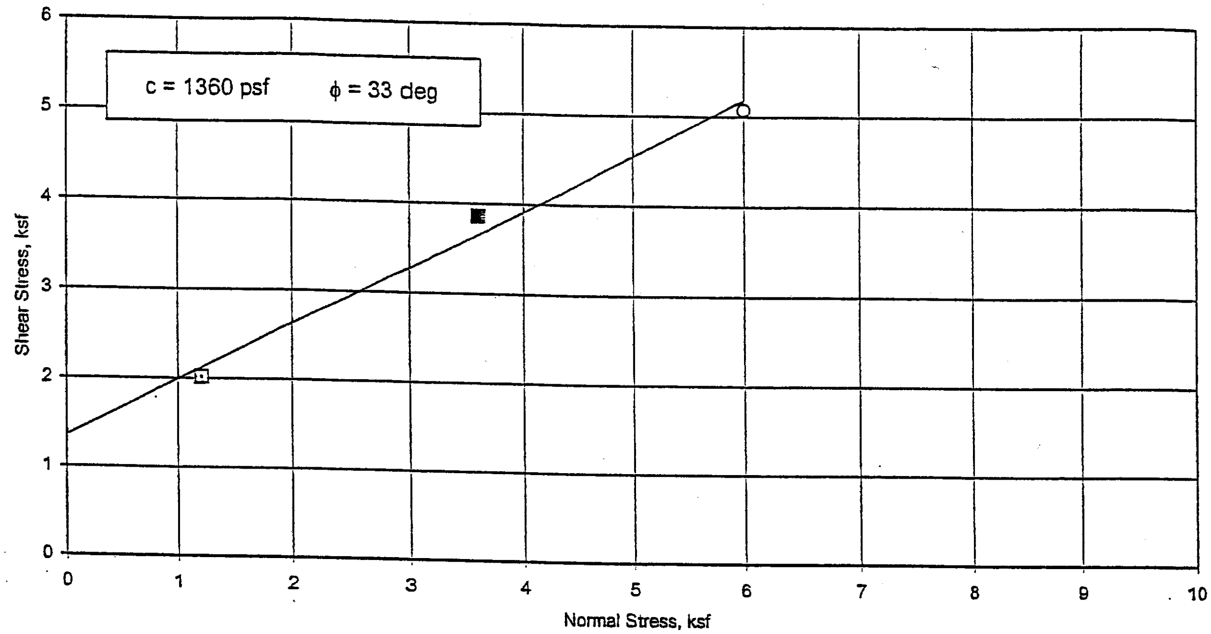
Type of Test: Consolidated Undrained/Unsaturated
Sample Description: Sandy Silt (ML) From: Test Pit DCW-6 @ 2.5'-6'

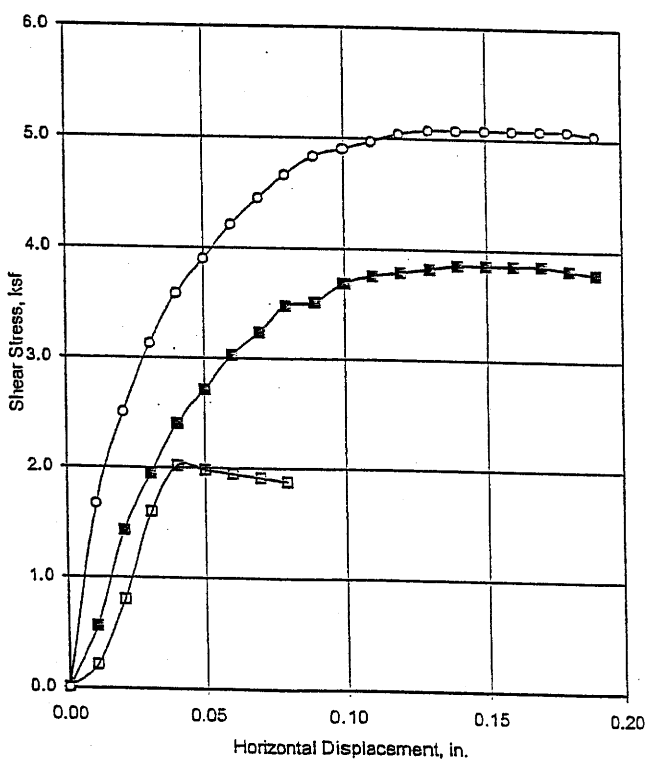
Project No. 1990648

DIRECT SHEAR TEST RESULTS

Figure 6

Applied Geotechnical Engineering Consultants, Inc.





Test No. (Symbol)	1(□)	2(■)	3(O)
Sample Type	Remolded		
Length, in.	1.00	1.00	1.00
Diameter, in.	1.93	1.93	1.93
Dry Density, pcf	98	98	98
Moisture Content, %	6	6	6
Consolidation Load, ksf	1.2	3.6	6.0
Normal Load, ksf	1.2	3.6	6.0
Shear Stress, ksf	2.02	3.86	5.08
Remarks	Strain Rate 0.05 in/min. Test performed on material passing the No. 4 sieve.		

Sample Index Properties	
Dry Density, pcf	N/A
Moisture Content, %	N/A
Liquid Limit, %	26
Plasticity Index, %	9
Percent Gravel	0
Percent Sand	15
Percent Passing No. 200 Sieve	85

Type of Test: Consolidated Undrained/Unsaturated

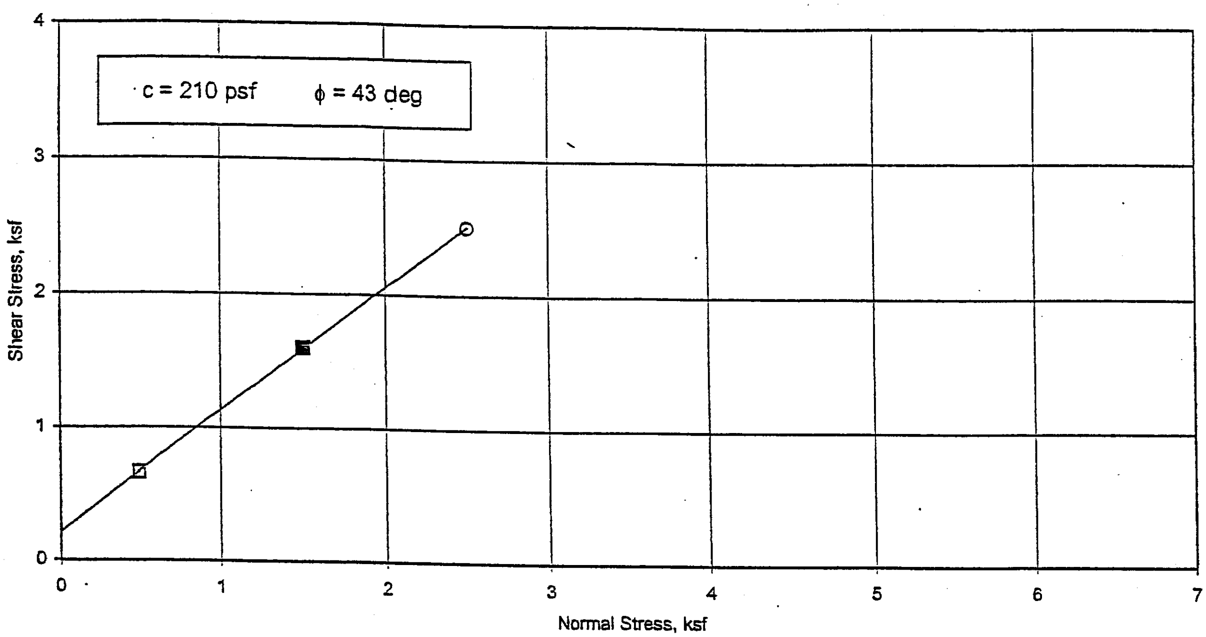
Sample Description: Lean Clay with Sand (CL) From Test Pit DCW-9 @ 0"-14"

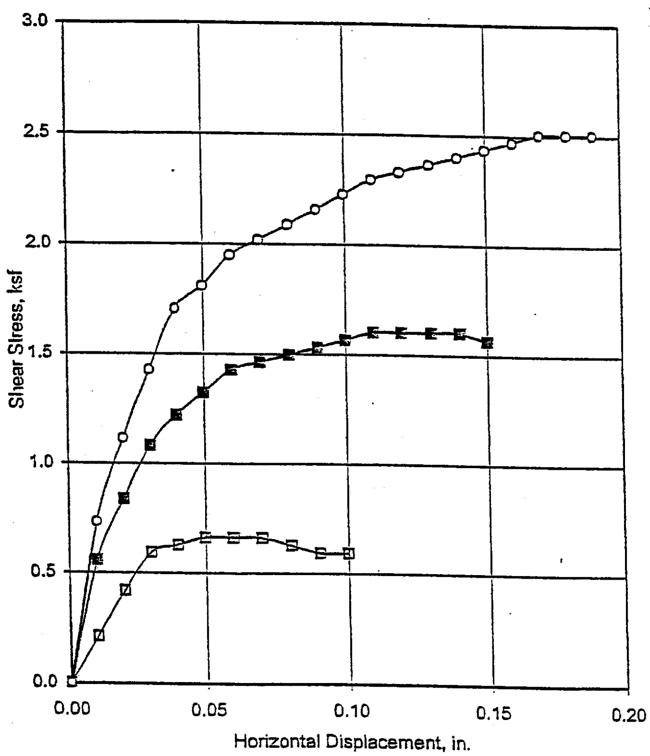
Project No. 1990648

DIRECT SHEAR TEST RESULTS

Figure 7

Applied Geotechnical Engineering Consultants, Inc.





Test No. (Symbol)	1(□)	2(■)	3(O)
Sample Type	Remolded		
Length, in.	1.00	1.00	1.00
Diameter, in.	1.93	1.93	1.93
Dry Density, pcf	100	100	100
Moisture Content, %	8	8	8
Consolidation Load, ksf	0.5	1.5	2.5
Normal Load, ksf	0.5	1.5	2.5
Shear Stress, ksf	0.66	1.60	2.51
Remarks	Strain Rate 0.05 in/min. Test performed on material passing the No. 4 sieve.		

Sample Index Properties	
Dry Density, pcf	N/A
Moisture Content, %	N/A
Liquid Limit, %	N/A
Plasticity Index, %	N/A
Percent Gravel	34
Percent Sand	34
Percent Passing No. 200 Sieve	32

Type of Test: Consolidated Undrained/Unsaturated
Sample Description: Silty Sand with Gravel (SM) From: Test Pit DCW-10 @ 13"-102"

Project No. 1990648

DIRECT SHEAR TEST RESULTS

Figure 8

```
TITLE
DUGOUT CANYON MINE
SEDIMENTATION POND OUTSLOPE
FULL POND WITH NO SEEPAGE
PROFIL
6 6
0 20 33 26 1
33 26 101 52 1
101 52 111 52 1
111 52 117 49 1
117 49 139 38 1
139 38 160 38 1
SOIL
2
115 125 210 43 0 0 1
115 125 140 28 0 0 1
WATER
1 62.4
2
117 49
160 49
CIRCL2
36 100 15 45 90 120 15 5 12 -30
END
```

****
*****   GeoSlope   *****
*****   Version 5.00   *****
*****   *****
*****   (c)1992 by GEOCOMP Corp, Concord, MA   *****
*****   Licensed to EarthFax Engineering   *****
****

Problem Title: DUGOUT CANYON MINE
Description: SEDIMENTATION POND OUTSLOPE
Remarks: FULL POND WITH NO SEEPAGE

****
*****   INPUT DATA   *****
****

Profile Boundaries

Number of Boundaries: 6
Number of Top Boundaries: 6

Boundary No.	X-Left (ft)	Y-Left (ft)	X-Right (ft)	Y-Right (ft)	Soil Type Below Bnd
1	0.00	20.00	33.00	26.00	1
2	33.00	26.00	101.00	52.00	1
3	101.00	52.00	111.00	52.00	1
4	111.00	52.00	117.00	49.00	1
5	117.00	49.00	139.00	38.00	1
6	139.00	38.00	160.00	38.00	1

Soil Parameters

Number of Soil Types: 2

Soil Type No.	Total Unit Wt. (pcf)	Saturated Unit Wt. (pcf)	Cohesion Intercept (psf)	Friction Angle (deg)	Pore Pressure Param.	Pressure Constant (psf)	Piez. Surface No.
1	115.0	125.0	210.0	43.0	0.00	0.0	1
2	115.0	125.0	140.0	28.0	0.00	0.0	1

Piezometric Surfaces

Number of Surfaces: 1
Unit Weight of Water: 62.40 pcf

Piezometric Surface No.: 1
Number of Coordinate Points: 2

Point No.	X-Water (ft)	Y-Water (ft)
1	117.00	49.00
2	160.00	49.00

****
*****   TRIAL SURFACE GENERATION   *****
****

Data for Generating Circular Surfaces

Number of Initiation Points:	36
Number of Surfaces From Each Point:	100
Left Initiation Point:	15.00 ft
Right Initiation Point:	45.00 ft
Left Termination Point:	90.00 ft
Right Termination Point:	120.00 ft
Minimum Elevation:	15.00 ft
Segment Length:	5.00 ft
Positive Angle Limit:	12.00 deg
Negative Angle Limit:	-30.00 deg

RESULTS

Critical Surfaces

No.	Safety Factor	Center X (ft)	Center Y (ft)	Circle Radius (ft)
1	3.589	42.03	111.89	88.27
2	3.589	41.98	112.47	88.84
3	3.589	42.37	107.49	84.00
4	3.590	41.62	117.30	92.45
5	3.593	40.49	112.20	88.04
6	3.593	39.45	116.74	92.67
7	3.596	38.73	118.20	94.30
8	3.598	45.24	99.69	75.62
9	3.599	45.10	103.84	80.64
10	3.599	39.55	114.13	91.26

```
TITLE
DUGOUT CANYON MINE
SEDIMENTATION POND OUTSLOPE
STEADY STATE SEEPAGE
PROFIL
8 6
0 20 33 26 1
33 26 101 52 1
101 52 111 52 1
111 52 117 49 1
117 49 139 38 2
139 38 160 38 2
0 10 33 16 2
33 16 117 49 2
SOIL
2
115 125 210 43 0 0 1
115 125 140 28 0 0 1
WATER
1 62.4
4
0 10
33 16
117 49
160 49
CIRCL2
36 100 15 45 90 120 15 5 12 -30
END
```

```
******************************************************************
*****                       GeoSlope                        *****
*****                     Version 5.00                      *****
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******************************************************************
```

Problem Title: DUGOUT CANYON MINE
Description: SEDIMENTATION POND OUTSLOPE
Remarks: STEADY STATE SEEPAGE

```
******************************************************************
*****                      INPUT DATA                       *****
******************************************************************
```

Profile Boundaries

Number of Boundaries: 8
Number of Top Boundaries: 6

Boundary No.	X-Left (ft)	Y-Left (ft)	X-Right (ft)	Y-Right (ft)	Soil Type Below Bnd
1	0.00	20.00	33.00	26.00	1
2	33.00	26.00	101.00	52.00	1
3	101.00	52.00	111.00	52.00	1
4	111.00	52.00	117.00	49.00	1
5	117.00	49.00	139.00	38.00	2
6	139.00	38.00	160.00	38.00	2
7	0.00	10.00	33.00	16.00	2
8	33.00	16.00	117.00	49.00	2

Soil Parameters

Number of Soil Types: 2

Soil Type No.	Total Unit Wt. (pcf)	Saturated Unit Wt. (pcf)	Cohesion Intercept (psf)	Friction Angle (deg)	Pore Pressure Param.	Pressure Constant (psf)	Piez. Surface No.
1	115.0	125.0	210.0	43.0	0.00	0.0	1
2	115.0	125.0	140.0	28.0	0.00	0.0	1

Piezometric Surfaces

Number of Surfaces:	1
Unit Weight of Water:	62.40 pcf

Piezometric Surface No.:	1
Number of Coordinate Points:	4

Point No.	X-Water (ft)	Y-Water (ft)
1	0.00	10.00
2	33.00	16.00
3	117.00	49.00
4	160.00	49.00

****

***** TRIAL SURFACE GENERATION *****

****

Data for Generating Circular Surfaces

Number of Initiation Points:	36
Number of Surfaces From Each Point:	100
Left Initiation Point:	15.00 ft
Right Initiation Point:	45.00 ft
Left Termination Point:	90.00 ft
Right Termination Point:	120.00 ft
Minimum Elevation:	15.00 ft
Segment Length:	5.00 ft
Positive Angle Limit:	12.00 deg
Negative Angle Limit:	-30.00 deg

****
***** RESULTS *****
****

Critical Surfaces

No.	Safety Factor	Center X (ft)	Center Y (ft)	Circle Radius (ft)
1	1.962	53.20	92.07	76.49
2	1.962	52.16	93.56	78.40
3	1.962	53.04	90.87	75.35
4	1.963	55.08	89.66	74.13
5	1.964	55.22	90.79	75.21
6	1.964	54.81	92.61	77.18
7	1.964	55.22	86.75	71.09
8	1.965	55.76	88.33	73.28
9	1.966	55.83	86.64	70.74
10	1.966	56.13	88.50	72.53

```
TITLE
DUGOUT CANYON MINE
SEDIMENTATION POND OUTSLOPE
STEADY STATE SEEPAGE WITH 0.18g EARTHQUAKE
PROFIL
8 6
0 20 33 26 1
33 26 101 52 1
101 52 111 52 1
111 52 117 49 1
117 49 139 38 2
139 38 160 38 2
0 10 33 16 2
33 16 117 49 2
SOIL
2
115 125 210 43 0 0 1
115 125 140 28 0 0 1
WATER
1 62.4
4
0 10
33 16
117 49
160 49
EQUAKE
0.18 0
CIRCL2
36 100 15 45 90 120 15 5 12 -30
END
```

```
*******************************************************************
*****                         GeoSlope                        *****
*****                       Version 5.00                      *****
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*******************************************************************
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Problem Title: DUGOUT CANYON MINE
Description: SEDIMENTATION POND OUTSLOPE
Remarks: STEADY STATE SEEPAGE WITH 0.18g EARTHQUAKE

```
*******************************************************************
*****                        INPUT DATA                       *****
*******************************************************************
```

Profile Boundaries

Number of Boundaries: 8
Number of Top Boundaries: 6

Boundary No.	X-Left (ft)	Y-Left (ft)	X-Right (ft)	Y-Right (ft)	Soil Type Below Bnd
1	0.00	20.00	33.00	26.00	1
2	33.00	26.00	101.00	52.00	1
3	101.00	52.00	111.00	52.00	1
4	111.00	52.00	117.00	49.00	1
5	117.00	49.00	139.00	38.00	2
6	139.00	38.00	160.00	38.00	2
7	0.00	10.00	33.00	16.00	2
8	33.00	16.00	117.00	49.00	2

Soil Parameters

Number of Soil Types: 2

Soil Type No.	Total Unit Wt. (pcf)	Saturated Unit Wt. (pcf)	Cohesion Intercept (psf)	Friction Angle (deg)	Pore Pressure Param.	Pressure Constant (psf)	Piez. Surface No.
1	115.0	125.0	210.0	43.0	0.00	0.0	1
2	115.0	125.0	140.0	28.0	0.00	0.0	1

Piezometric Surfaces

Number of Surfaces:	1
Unit Weight of Water:	62.40 pcf

Piezometric Surface No.:	1
Number of Coordinate Points:	4

Point No.	X-Water (ft)	Y-Water (ft)
1	0.00	10.00
2	33.00	16.00
3	117.00	49.00
4	160.00	49.00

Earthquake Loading

Horizontal Acceleration Coefficient:	0.180
Vertical Acceleration Coefficient:	0.000

****
*****   TRIAL SURFACE GENERATION   *****
****

Data for Generating Circular Surfaces

Number of Initiation Points:	36
Number of Surfaces From Each Point:	100
Left Initiation Point:	15.00 ft
Right Initiation Point:	45.00 ft
Left Termination Point:	90.00 ft
Right Termination Point:	120.00 ft
Minimum Elevation:	15.00 ft
Segment Length:	5.00 ft
Positive Angle Limit:	12.00 deg
Negative Angle Limit:	-30.00 deg

****
*****   RESULTS   *****
****

Critical Surfaces

No.	Safety Factor	Center X (ft)	Center Y (ft)	Circle Radius (ft)
1	1.237	51.84	103.07	87.89
2	1.238	51.43	106.47	90.37
3	1.238	52.21	104.37	88.25
4	1.238	51.81	106.84	90.38
5	1.239	53.27	103.63	87.03
6	1.239	52.87	105.87	88.95
7	1.239	54.66	99.88	83.67
8	1.239	51.33	103.00	87.62
9	1.240	55.10	99.93	83.40
10	1.240	51.92	101.69	86.17

```
TITLE
DUGOUT CANYON MINE
SEDIMENTATION POND INSLOPE
INSLOPE WITH RAPID DRAWDOWN
PROFIL
8 6
0 38 21 38 2
21 38 43 49 2
43 49 49 52 1
49 52 59 52 1
59 52 127 26 1
127 26 160 20 1
43 49 127 16 2
127 16 160 10 2
SOIL
2
115 125 210 43 0 0 0
115 125 140 28 0 0 0
CIRCL2
27 100 0 26 43 55 15 3 12 -30
END
```

```
*******************************************************************
*****                        GeoSlope                        *****
*****                      Version 5.00                      *****
*****                                                        *****
*****        (c)1992 by GEOCOMP Corp, Concord, MA            *****
*****          Licensed to EarthFax Engineering              *****
*******************************************************************
```

Problem Title: DUGOUT CANYON MINE
Description: SEDIMENTATION POND INSLOPE
Remarks: INSLOPE WITH RAPID DRAWDOWN

```
*******************************************************************
*****                       INPUT DATA                       *****
*******************************************************************
```

Profile Boundaries

Number of Boundaries: 8
Number of Top Boundaries: 6

Boundary No.	X-Left (ft)	Y-Left (ft)	X-Right (ft)	Y-Right (ft)	Soil Type Below Bnd
1	0.00	38.00	21.00	38.00	2
2	21.00	38.00	43.00	49.00	2
3	43.00	49.00	49.00	52.00	1
4	49.00	52.00	59.00	52.00	1
5	59.00	52.00	127.00	26.00	1
6	127.00	26.00	160.00	20.00	1
7	43.00	49.00	127.00	16.00	2
8	127.00	16.00	160.00	10.00	2

Soil Parameters

Number of Soil Types: 2

Soil Type No.	Total Unit Wt. (pcf)	Saturated Unit Wt. (pcf)	Cohesion Intercept (psf)	Friction Angle (deg)	Pore Pressure Param.	Pressure Constant (psf)	Piez. Surface No.
1	115.0	125.0	210.0	43.0	0.00	0.0	0
2	115.0	125.0	140.0	28.0	0.00	0.0	0

****
*****   TRIAL SURFACE GENERATION   *****
****

Data for Generating Circular Surfaces

Number of Initiation Points:	27
Number of Surfaces From Each Point:	100
Left Initiation Point:	0.00 ft
Right Initiation Point:	26.00 ft
Left Termination Point:	43.00 ft
Right Termination Point:	55.00 ft
Minimum Elevation:	15.00 ft
Segment Length:	3.00 ft
Positive Angle Limit:	12.00 deg
Negative Angle Limit:	-30.00 deg

****
*****   RESULTS   *****
****

Critical Surfaces

No.	Safety Factor	Center X (ft)	Center Y (ft)	Circle Radius (ft)
1	2.233	27.31	67.17	29.85
2	2.236	27.04	65.16	28.06
3	2.238	28.44	62.97	26.05
4	2.240	26.74	67.37	30.13
5	2.243	26.63	68.06	30.78
6	2.245	26.05	67.84	30.44
7	2.245	27.05	64.88	28.06
8	2.245	27.05	64.83	28.01
9	2.245	26.92	66.20	29.29
10	2.246	27.87	62.10	25.35

Canyon Fuel Company, LLC
Dugout Canyon Mine

Refuse Pile Amendment
February 2005

RA ATTACHMENT 5-2

REFUSE PILE SLOPE STABILITY EVALUATION

RA ATTACHMENT 5-2

REFUSE PILE SLOPE STABILITY EVALUATION

LICENSED PROFESSIONAL ENGINEER
No. 168246
RICHARD B. WHITE
4/10/2002
STATE OF UTAH

EarthFax

EarthFax
Engineering Inc.
Engineers/Scientists
7324 So. Union Park Ave.
Suite 100
Midvale, Utah 84047
Telephone 801-561-1555
Fax 801-561-1861

May 15, 2001

Mr. Chris Hansen
Canyon Fuel Company, LLC
Dugout Canyon Mine
HC35 Box 380
Helper, Utah 84526

Subject: Results of a foundation investigation and slope stability analysis for a proposed waste-rock pile for the Dugout Canyon Mine

Dear Chris:

The purpose of this letter is to present the results of a foundation investigation and slope stability analysis for a proposed waste-rock pile for the Dugout Canyon Mine near Wellington, Utah. The proposed waste-rock pile is located about 4.5 miles southwest of the mine. The project was conducted in general accordance with the proposal from EarthFax dated September 8, 1999.

BACKGROUND INFORMATION

The site was originally investigated by RB&G Engineering, Inc. (1998; Provo, Utah) as a potential borrow source for granular fill used at the Dugout Canyon Mine. The results of that investigation indicated that the native soils consisted of interbedded layers of gravel and clay overlying Mancos Shale. Following removal and stockpiling of the topsoil, the underlying granular soils were excavated, crushed, screened, and transported to the Dugout Canyon Mine. The excavation typically continued downward until weathered Mancos Shale was encountered. As a result, the remaining soil at the site consisted primarily of thin layers of granular alluvium overlying weathered Mancos Shale and Mancos Shale bedrock.

The topography of the site following removal of the surficial granular soils and stockpiling of the topsoil is shown in Figure 1 (attached). As shown on Figure 1, the site has an irregular shape with most of the surface area present at the north end. Dugout Canyon Mine proposes to construct a waste-rock pile along the east-half of the north end of the site. Mine construction materials (i.e., timbers) will be temporarily stockpiled at the west-half of the north end of the site. This area will also be used to pile snow removed from the working areas around the mine. A sedimentation pond to contain surface water runoff will be constructed at the south end of the site in a depression that was formed during removal of the surficial granular soils.

Based on preliminary design information, the north edge of the waste-rock pile will only be about 2 feet high. The waste-rock pile will be placed with a longitudinal peak along the north-south axis that slopes southward at about 2 percent. From the peak, the waste-rock pile surface will also slope toward the east and west at about 2 percent. Because the 2% waste-rock slope is less than the slope of the existing ground surface, the thickness of the waste-rock pile will gradually increase progressing toward the south to a maximum thickness of about 10 feet at the south end. The waste-rock pile outslope will be constructed at about 3 horizontal to 1 vertical. The outside toe of the east and south ends of the waste-rock pile will be maintained about 10 feet inward of the top of the existing native slope. This 10-foot area will be sloped from the waste-rock pile at about 10 horizontal to 1 vertical to a ditch/berm to contain surface-water runoff, which will be directed toward the proposed sedimentation pond at the south end of the site.

SOILS INFORMATION

As part of this investigation, EarthFax installed ten shallow test pits using a rubber tire backhoe. The locations of the test pits are presented in Figure 1 (attached). Test Pits DCW-1 through DCW-9 were excavated within the area from which granular alluvium was removed (see the previous section). Two of these test pits (DCW-1 and DCW-2) were excavated within the footprint of the proposed waste rock pile. Native soil properties were evaluated beyond the disturbed area by excavating one test pit (DCW-10) south of the proposed waste-rock pile. The test pits were logged by a geotechnical engineer from EarthFax and by a soil scientist from EIS, Inc. (Salt Lake City, Utah). EarthFax's test pit logs are attached. Nuclear density/moisture tests were conducted on the surface soils at most of the test pits to provide remolding criteria for samples submitted for direct shear tests. Select samples were submitted to Applied Geotechnical Engineering Consultants, Inc. (Sandy, Utah) for geotechnical laboratory analyses.

According to the test pit logs, a thin layer (2 to 2.2 feet thick) of weathered Mancos Shale over Mancos Shale bedrock was encountered at Test Pits DCW-3 and DCW-9. Remnants (2.7 to 9 feet thick) of gravelly sand alluvium were encountered at Test Pits DCW-1, DCW-2, DCW-4, and DCW-5. Mancos Shale bedrock was encountered below the alluvial soil at Test Pits DCW-1 and DCW-4. Test Pit DCW-6 contained layers of silty sand and sandy silt to a depth of 6 feet overlying gravelly sand to a depth of 7.5 feet. Test Pit DCW-7 encountered some coal, gravel, and soil to a depth of 0.7 feet, silty sand alluvium to a depth of 6 feet, and gravelly sand alluvium to a depth of about 7 feet. Stockpiled topsoil was encountered to a depth of 5 feet at Test Pit DCW-8, under which a gravelly sand alluvium extended to the bottom of the test pit at a depth of 6.5 feet.

Beyond the disturbed area at Test Pit DCW-10, the soils consisted of a silty sand topsoil to a depth of 1.1 feet over a gravelly sand layer to the bottom of the test pit at a depth of 8.5 feet.

Results of the laboratory analyses are attached and are summarized in Table 1. Direct shear tests were conducted on samples that were remolded to the same dry density and moisture contents that were recorded in the field from the nuclear density/moisture tests. According to the data in Table 1, the soil property parameters are as follows:

- **Weathered Mancos Shale (Test Pits DCW-3 and DCW-9):** The material contained 0 to 49% gravel, 15 to 16% sand, 25 to 61% silt, and 10 to 24% clay. According to the Atterberg Limits data, the liquid limit was 26 to 33, the plastic limit was 17 to 18, and the plastic index was 9 to 15. The angle of internal friction ranged between 33 and 37 degrees, and the cohesion intercept values ranged between 1320 and 1360 pounds per square foot ("psf"). The direct shear tests were conducted under consolidated, undrained, unsaturated (moist) conditions.

- **Gravelly Sand Alluvium (Test Pit DCW-1):** The material contained 52% gravel, 30% sand, and 18% silt. The angle of internal friction was 43 degrees and the soil was noncohesive from direct shear tests conducted under consolidated, undrained, unsaturated (moist) conditions.

- **Sandy Silt (Test Pit DCW-6):** The material contained 59% silt and 41% sand. The angle of internal friction was 45 degrees and the soil was noncohesive from direct shear tests conducted under consolidated, undrained, unsaturated (moist) conditions.

- **Native Soil Beyond the Disturbed Area (Test Pit DCW-10):** The material contained 34% gravel, 34% sand, and 32% silt. The angle of internal friction was 43 degrees and the cohesion intercept value was 210 psf from direct shear tests conducted under consolidated, undrained, unsaturated (moist) conditions.

WASTE-ROCK

The waste-rock to be placed at the site will originate as roof-fall and other rock materials removed from the Dugout Canyon Mine. Similar waste-rock had been tested for a slope stability analysis of a temporary waste-rock pile at the Dugout Canyon Mine. The results of this analysis were presented in a letter dated July 27, 1998 from EarthFax to Canyon Fuel Company. As part of that investigation, gradation, Atterberg Limits, Standard Proctor compaction, and direct shear tests were conducted on the waste-rock. Results of these analyses are attached (data sheets dated July 15, 1998). According to these analyses, the waste-rock is coarse-grained with about 95% retained on the No. 200 sieve (i.e., sand fraction or larger), and about 82% retained on the No. 4 sieve (i.e., gravel fraction). The material is poorly-graded with a Unified Soil Classification of GP-GM. The sample had an angle of internal friction of 35 degrees and a cohesion strength of 490 pounds per square foot. These strength parameters will be used for the slope stability analysis of the proposed waste-rock pile.

ASSUMPTIONS

The following assumptions were made for the slope stability analyses:

1. The outslope of the waste-rock pile will be placed at a slope of 3 horizontal to 1 vertical (about 18 degrees) to a maximum height of 10 feet. The outslope toe of the waste-rock pile will be maintained about 10 feet inward of the top of the existing native slope. The surface of the waste-rock pile will be placed with a slope of about 2 percent.

2. As a worst-case condition, the native soil has a maximum slope of 30 degrees for a height of 40 feet. The topography of the existing native slope east and south of the proposed waste-rock pile in Figure 1 indicates that the native slope typically ranges between 20 and 30 degrees (near Section A-A' in Figure 1) with a maximum height of less than 40 feet.

3. As a worst-case condition, the native soil is vertically continuous and the failure surfaces do not intersect the Mancos Shale bedrock. This assumption was included because the Mancos Shale bedrock surface is variable throughout the site.

4. The soil property parameters used for the analyses are representative of the native soils throughout the site. In the interest of conservatism, the weakest soils from the direct shear tests were used for the analyses, which were as follows (see Table 1):

	Granular Soil	Weathered Mancos Shale
Angle of Internal Friction (degrees)	43	33
Cohesive Strength (psf)	0	1360

5. The soils do not become saturated, and there is no phreatic surface. The soils drain rapidly, and excess pore pressures do not develop in response to strains and stress changes.

6. The results of direct shear tests on the waste-rock presented in the letter dated July 27, 1998 from EarthFax to Canyon Fuel Company are representative of the proposed waste-rock pile. Therefore, the angle of internal friction of the waste-rock is 35 degrees and the cohesive strength is 490 pounds per square foot.

RESULTS

Slope stability analyses were performed using the computer program GEOSLOPE (Version 5.0). GEOSLOPE utilizes the limit equilibrium procedure of slices (Simplified Bishop's method) to determine the safety factor of potential failure surfaces for circular shapes.

Using the assumptions presented above, results of the slope stability analyses are attached and are summarized in Table 2 (attached). The results of the stability analyses include the data files and the output files. Table 2 includes a description of the analysis slope, the number of trial failure surfaces, and the safety factor against sliding. From Table 2, the critical safety factor was 1.62 for failure surfaces originating at the toe of the native slope (alluvial soil) and terminating in the waste-rock pile. When soil strength parameters for weathered Mancos Shale were used for the native soils, the safety factor increased to 3.73. The critical safety factor was 7.48 for failure surfaces originating and terminating in the waste-rock pile. These values satisfy the minimum regulatory requirement of 1.5 promulgated by the Utah Division of Oil, Gas, and Mining (R645-301-536.110). Because the effects of bedrock were not included in the analyses, the results are considered to be conservative.

We have appreciated the opportunity to provide this information. If you have any questions, please call.

Sincerely,

Rhett Brooks

Rhett Brooks, P.E.
EarthFax Engineering, Inc.

cc: Tom Suchoski, EarthFax

REGISTERED PROFESSIONAL ENGINEER
92-187704-2202
RHETT K. BROOKS
STATE OF UTAH

Rhett Brooks

May 15, 2001

REFERENCES

RB&G Engineering, Inc. 1998. Canyon Fuel Company, Dugout Canyon Surface Coal Handling Facilities near Wellington, Utah. Project report dated June 1998 prepared for Canyon Fuel Company. Provo, Utah.

Utah Division of Oil, Gas, and Mining. 1996. Utah Coal Mining Regulations. Salt Lake City, Utah.

TABLE 1

SUMMARY OF LABORATORY TEST RESULTS

Test Pit and Depth (Ft.)	Gradation (%)				Atterberg Limits			Direct Shear Test Values	
	Gravel	Sand	Silt	Clay	Liquid Limit	Plastic Index	Plastic Limit	Cohesive Strength (psf)	Angle of Internal Friction (degrees)
DCW-1 0-3.2[a]	52	30	18		--	--	--	0	43
DCW-3 0-2.2[b]	49	16	25	10	33	15	18	1320	37
DCW-6 2.5-6[c]	0	41	59		--	--	--	0	45
DCW-9 0-1.2[d]	0	15	61	24	26	9	17	1360	33
DCW-10 1.1-8.5[e]	34	34	32		--	--	--	210	43

(a) Alluvium. Sample for direct shear test remolded to a dry density of 115 pcf at a moisture content of 6%, which were the results of a nuclear density/moisture test conducted on the ground surface near the test pit. Direct shear test conducted under consolidated-undrained (CU) unsaturated conditions with vertical effective pressures of 1200, 3600, and 6000 psf.

(b) Weathered Mancos Shale. Direct shear test samples remolded to a dry density of 113 pcf at a moisture content of 6%, which were the results of a nuclear tests conducted on the ground surface near the test pit. Direct shear test conducted under consolidated-undrained (CU) unsaturated conditions with vertical effective pressures of 1200, 3600, and 6000 psf.

(c) Silty sand. Sample for direct shear test remolded to a dry density of 112 pcf at a moisture content of 9%, which were the results of a nuclear density/moisture test conducted on the ground surface near the test pit. Direct shear test conducted under consolidated-undrained (CU) unsaturated conditions with vertical effective pressures of 1200, 3600, and 6000 psf.

(d) Weathered Mancos Shale. Direct shear test samples remolded to a dry density of 98 pcf at a moisture content of 6%, which were the results of a nuclear test conducted on the ground surface near the test pit. Direct shear test conducted under consolidated-undrained (CU) unsaturated conditions with vertical effective pressures of 1200, 3600, and 6000 psf.

(e) Silty Sand. Direct shear test samples remolded to a dry density of 100 pcf at a moisture content of 8%, which were the results of a nuclear test conducted on the ground surface near the test pit. Direct shear test conducted under consolidated-undrained (CU) unsaturated conditions with vertical effective pressures of 500, 1500, and 2500 psf.

TABLE 2

RESULTS OF SLOPE STABILITY ANALYSES

Slope	Number of Trial Failure Surfaces	Safety Factor
Native Soil (Alluvium) and Waste-Rock Pile	930	1.62
Native Soil (Mancos Shale) and Waste-Rock Pile	930	3.73
Waste-Rock Pile	660	7.48

RA ATTACHMENT 5-2

REFUSE PILE SLOPE STABILITY EVALUATION

Replaces Figure 1, which is not legible in current submittal.

TEST PIT DCW-1
(Excavated and logged on September 16, 1999)

Depth (ft.)	Description
0 - 3.2	Sandy Gravel w/ Silt and Cobbles. Alluvium. About 42% gravel, 30% sand, 10% cobbles, and 18% silt. Sand is typically fine to coarse grained. Cobbles are up to 7 inches in diameter, subround. Gravel is subround to subangular. Moist. No cementation or cohesion. Good foundation material or fill material. From a 12-inch nuclear density/moisture test: moisture content = 5.7%, dry density = 115.5 pounds per cubic foot, wet density = 122.1 pounds per cubic foot. Brown 10YR 4/3. GM.
3.2 - 4.6	Mancos Shale Bedrock. Fractured. Gray. Hard to dig.

TEST PIT DCW-2
(Excavated and logged on September 16, 1999)

Depth (ft.)	Description
0 - 7.7	Gravelly Sand w/ Silt, Cobbles, and Boulders. Alluvium. About 45% sand, 25% gravel, 15% cobbles/boulders, and 15% silt. Sand is typically fine to coarse grained. Gravel is subround to subangular. Moist. No cementation or cohesion. Good foundation material or fill material. From a 8-inch nuclear density/moisture test: moisture content = 7.8%, dry density = 115.0 pounds per cubic foot, wet density = 124.0 pounds per cubic foot. Brown 10YR 4/3. Boulders at bottom impeded digging deeper. SM.

TEST PIT DCW-3
(Excavated and logged on September 16, 1999)

Depth (ft.)	Description
0 - 2.2	Weathered Mancos Shale. 49% gravel (fractured Mancos Shale), 16% sand, 25% silt, and 10% clay. Loose in top 3 inches, firmer and less weathered with depth. From a 12-inch nuclear density/moisture test: moisture content = 5.6%, dry density = 112.6 pounds per cubic foot, wet density = 118.8 pounds per cubic foot.
2.2 - 3.2	Mancos Shale Bedrock. Fractured and slightly weathered. Gray. Hard to dig.

TEST PIT DCW-4
(Excavated and logged on September 16, 1999)

Depth (ft.)	Description
0 - 2.7	Gravelly Sand w/ Silt. Alluvium. About 55% sand, 20% gravel, 10% cobbles, and 15% silt. Sand is typically fine to coarse grained. Cobbles are up to 7 inches in diameter, subround. Gravel is subround to subangular. Moist. No cementation or cohesion. Good foundation material or fill material. From a 12-inch nuclear density/moisture test: moisture content = 5.7%, dry density = 115.5 pounds per cubic foot, wet density = 122.1 pounds per cubic foot. Brown 10YR 4/3. SM.
2.7 - 3.2	Mancos Shale Bedrock. Fractured. Gray. Hard to dig.

TEST PIT DCW-5
(Excavated and logged on September 16, 1999)

Depth (ft.)	Description
0 - 9	Gravelly Sand w/ Silt. Alluvium. About 55% sand, 20% gravel, 10% cobbles, and 15% silt. Sand is typically fine to coarse grained. Cobbles are up to 7 inches in diameter, subround. Gravel is subround to subangular. Moist. No cementation or cohesion. Good foundation material or fill material. From a 12-inch nuclear density/moisture test: moisture content = 5.7%, dry density = 115.5 pounds per cubic foot, wet density = 122.1 pounds per cubic foot. Brown 10YR 4/3. SM.

TEST PIT DCW-6
(Excavated and logged on September 16, 1999)

Depth (ft.)	Description
0 - 1.5	Silty Sand. About 60% sand and 40% silt. Sand is very fine to fine grained. Nonplastic. Numerous large roots from pine trees. From a 12-inch nuclear density/moisture test: moisture content = 8.8%, dry density = 102.9 pounds per cubic foot, wet density = 111.9 pounds per cubic foot. Yellowish brown 10YR 5/4. SM.
1.5 - 2.5	Sandy Silt. About 65% silt and 35% silt. Sand is very fine grained. Low plasticity, somewhat cohesive. Dry and hard. Very friable. ML.
2.5 - 6	Sandy Silt. About 59% silt and 41% sand. Sand is very fine grained. Nonplastic. Probably a blow sand layer. Light yellowish brown 2.5Y 6/3. ML.
6 - 7.5	Gravelly Sand w/ Silt. Alluvium. About 55% sand, 20% gravel, 10% cobbles/boulders, and 15% silt. Sand is typically fine to coarse grained. Gravel is subround to subangular. Moist. No cementation or cohesion. Brown 10YR 4/3. SM.

TEST PIT DCW-7
(Excavated and logged on September 16, 1999)

Depth (ft.)	Description
0 - 0.7	Mix of Rubbish. Mix of coal, sandstone, and dark brown soil (silt through cobbles). SM.
0.7 - 6	Silty Sand w/ Gravel. Alluvium. About 70% sand, 10% gravel/cobbles, 20% silt. Sand is typically fine to coarse grained. Gravel is subround to subangular. Moist. No cementation or cohesion. Brown 10YR 4/3. SM.
6 - 7	Gravelly Sand w/ Silt. Alluvium. About 55% sand, 20% gravel, 10% cobbles, and 15% silt. Sand is typically fine to coarse grained. Gravel is subround to subangular. Moist. No cementation or cohesion. Brown 10YR 4/3. SM.

TEST PIT DCW-8
Topsoil Stockpile
(Excavated and logged on September 16, 1999)

Depth (ft.)	Description
0 - 5	Topsoil Stockpile. Topsoil that had been stripped from the site and piled in this area. Primarily silty sand with gravel and organic matter.
5 - 6.5	Gravelly Sand w/ Silt. Alluvium. About 55% sand, 20% gravel, 10% cobbles, and 15% silt. Sand is typically fine to coarse grained. Gravel is subround to subangular. Moist. No cementation or cohesion. Brown 10YR 4/3. SM.

TEST PIT DCW-9
(Excavated and logged on September 16, 1999)

Depth (ft.)	Description
0 - 2	Weathered Mancos Shale. 61% silt, 24% clay, and 15% sand. Loose in top 14 inches, firmer and less weathered with depth. From a 12-inch nuclear density/moisture test: moisture content = 5.7%, dry density = 98.3 pounds per cubic foot, wet density = 103.8 pounds per cubic foot. CL.
2 - 2.5	Mancos Shale Bedrock. Fractured and slightly weathered. Gray. Hard to dig.

TEST PIT DCW-10
Near Proposed Sedimentation Pond Embankment
(Excavated and logged on September 16, 1999)

Depth (ft.)	Description
0 - 1.1	Silty Sand Topsoil. About 75% sand and 25% silt. Sand is very fine to fine grained. Nonplastic. Numerous fine roots. From a 12-inch nuclear density/moisture test: moisture content = 8.2%, dry density = 95.9 pounds per cubic foot, wet density = 103.7 pounds per cubic foot. Brown 10YR 4/3. SM.
1.1 - 8.5	Gravelly Sand w/ Silt. Alluvium. About 34% sand, 34% gravel/cobbles, and 32% silt. Sand is typically fine to coarse grained. Gravel is subround to subangular. Moist. No cementation or cohesion. Brown 10YR 4/3. SM.

Applied Geotechnical Engineering Consultants, Inc.

July 15, 1998

TESTS CONDUCTED FOR SLOPE STABILITY ANALYSES OF A TEMPORARY WASTE-ROCK PILE AT THE DUGOUT CANYON MINE. RESULTS PRESENTED IN A LETTER DATED JULY 27, 1998, FROM EARTHFAX ENGINEERING TO CANYON FUEL COMPANY. RKB

Earthfax Engineering
7324 South 1300 East, Suite 100
Midvale, UT 84047

Attention: Richard B. White

Subject: Soils Laboratory Testing
AGEC Project No. 973301

Gentlemen:

Applied Geotechnical Engineering Consultants, Inc. was requested to provide laboratory testing on a sample received July 2, 1998. The following tests have been performed in general accordance with the test method listed.

Test	Test Method
Particle Size Analysis	ASTM D-422
Atterberg Limits	ASTM D-4318
Direct Shear	ASTM D-3080
Standard Proctor	ASTM D-698

The results of the laboratory testing are shown graphically in Figures 1-2. The direct shear test specimens were remolded to approximately 90% of the standard proctor maximum dry density near optimum moisture content. Only material passing the #4 sieve was used in direct shear testing.

If you have any questions, or if we can be of further service, please call.

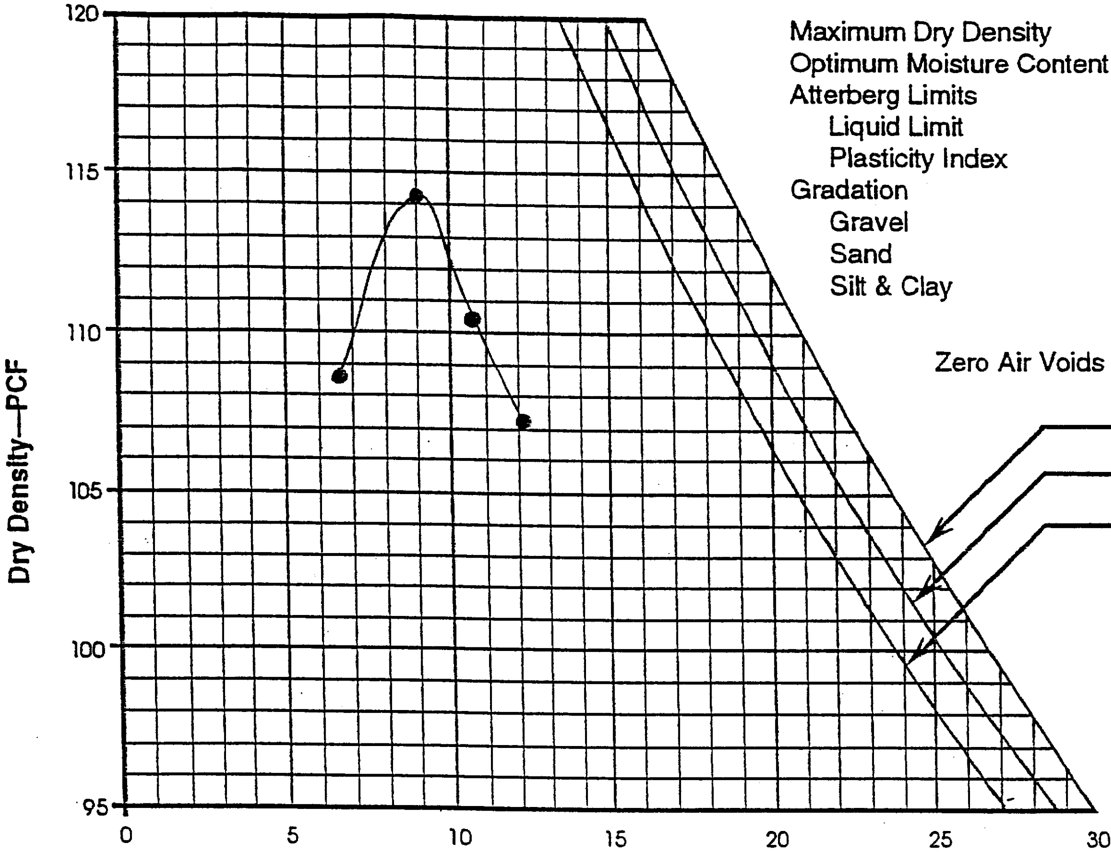
Sincerely,

APPLIED GEOTECHNICAL ENGINEERING CONSULTANTS, INC.

Stephanie Francom

Stephanie Francom
Rev. SDA, E.I.T.

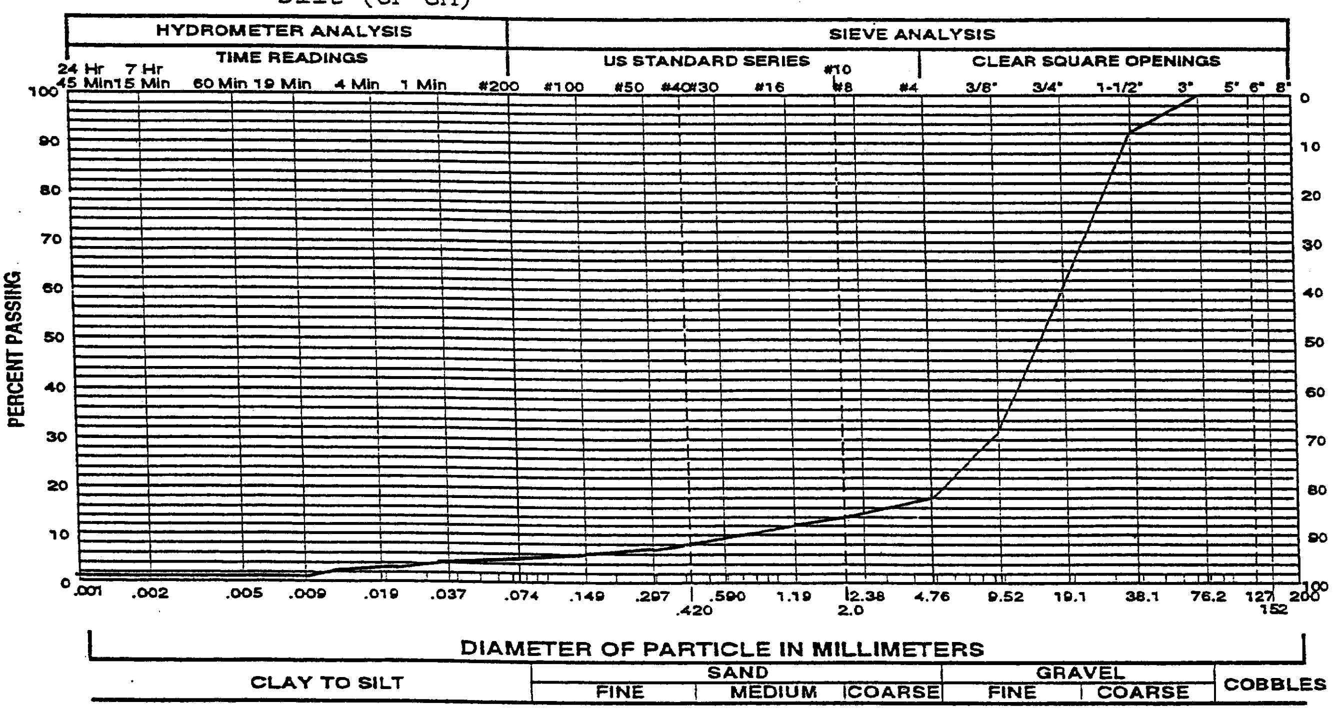
Applied Geotechnical Engineering Consultants, Inc.



Maximum Dry Density	114.0	pcf
Optimum Moisture Content	9.0	%
Atterberg Limits		
Liquid Limit	30	%
Plasticity Index	6	%
Gradation		
Gravel	82	%
Sand	13	%
Silt & Clay	5	%

Compaction Test Procedure ASTM D-698 Method D

Sample of: Poorly-Graded Gravel with Silt (GP-GM) From: DCM-1 (7/6/98)

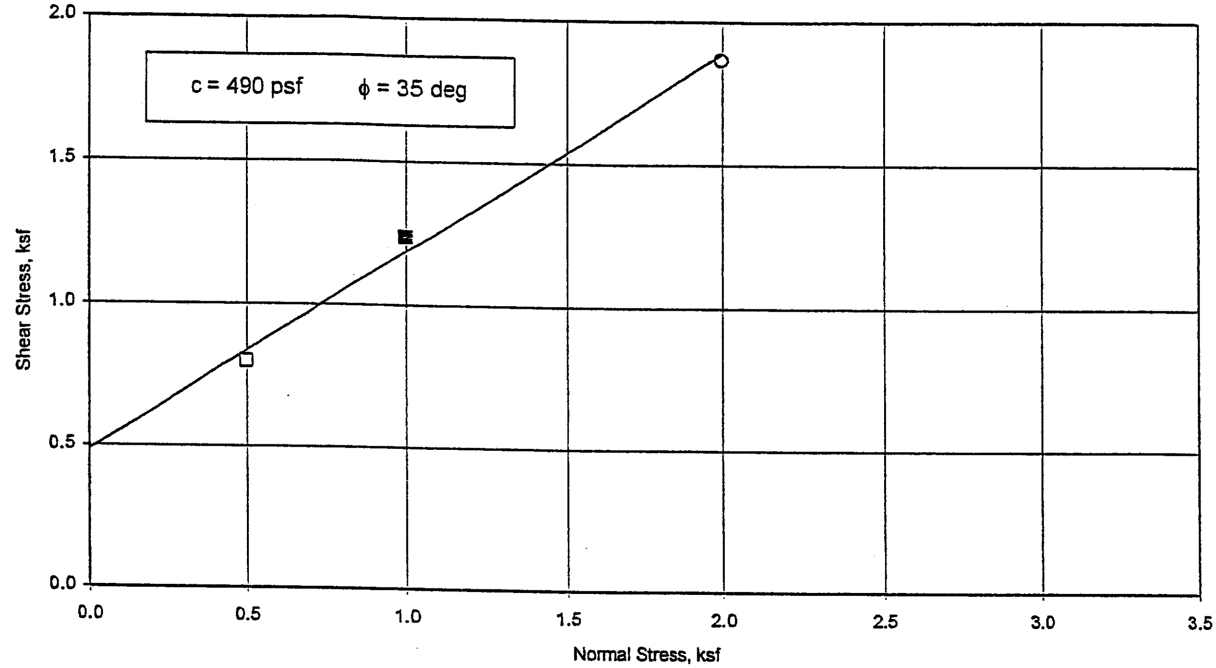


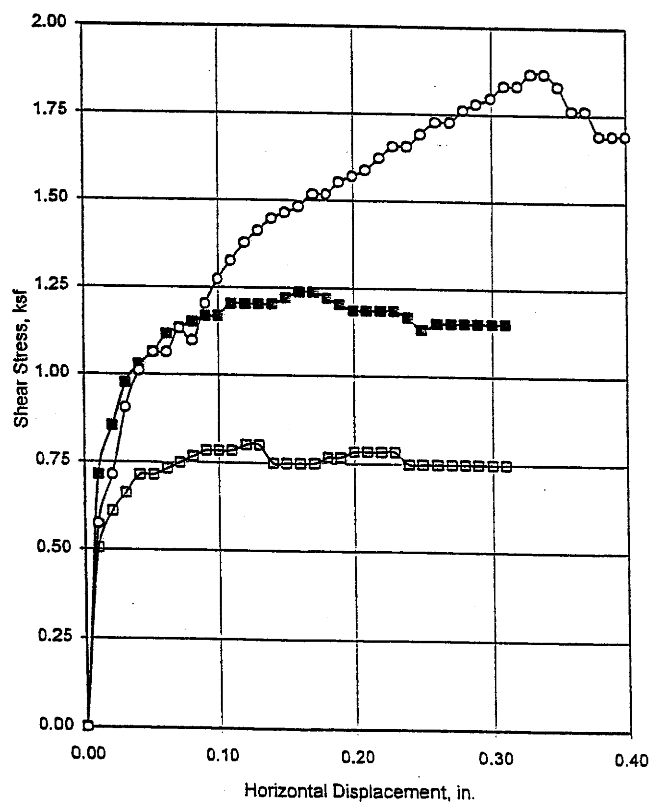
Project No. 973301

GRADATION & COMPACTION TEST RESULTS

Figure 1

Applied Geotechnical Engineering Consultants, Inc.





Test No. (Symbol)	1(□)	2(■)	3(O)
Sample Type	Remolded		
Length, in.	0.75	0.75	0.75
Diameter, in.	1.93	1.93	1.93
Dry Density, pcf	112	112	112
Moisture Content, %	9	9	9
Consolidation Load, ksf	0.5	1.0	2.0
Normal Load, ksf	0.5	1.0	2.0
Shear Stress, ksf	0.80	1.24	1.87
Remarks	Strain Rate 0.05 in/min. Only soil passing the #4 sieve was used in test.		

Sample Index Properties	
Dry Density, pcf	N/A
Moisture Content, %	N/A
Liquid Limit, %	30
Plasticity Index, %	6
Percent Gravel	82
Percent Sand	13
Percent Passing No. 200 Sieve	5

Type of Test: Consolidated Undrained/Saturated

Sample Description: Poorly Graded Gravel with Silt (GP-GM) From: DCM-1

Project No. 973301

DIRECT SHEAR TEST RESULTS

Figure 2

Applied Geotechnical Engineering Consultants, Inc.

October 19, 1999

Earthfax Engineering
7324 South 1300 East, Suite 100
Midvale, UT 84047

Attention: Rhett Brooks

Subject: Soil Testing for Waste Rock Pile Foundation Investigation
Dugout Canyon, Utah
AGEC Project No. 1990648

Gentlemen:

Applied Geotechnical Engineering Consultants, Inc. was requested to provide laboratory testing on five bucket samples delivered to our laboratory September 17, 1999. The following tests were performed in general accordance with the test methods listed.

Test	Test Method
Particle Size Analysis	ASTM D 422
Atterberg Limits	ASTM D 4318
Direct Shear	ASTM D 3080

The results of the laboratory testing are summarized in Table I and shown graphically in Figures 1 through 8.

If you have any questions, or if we can be of further service, please call.

Sincerely,

APPLIED GEOTECHNICAL ENGINEERING CONSULTANTS, INC.

Stephanie Merkley

Stephanie Merkley

Reviewed by SDA, E.I.T.

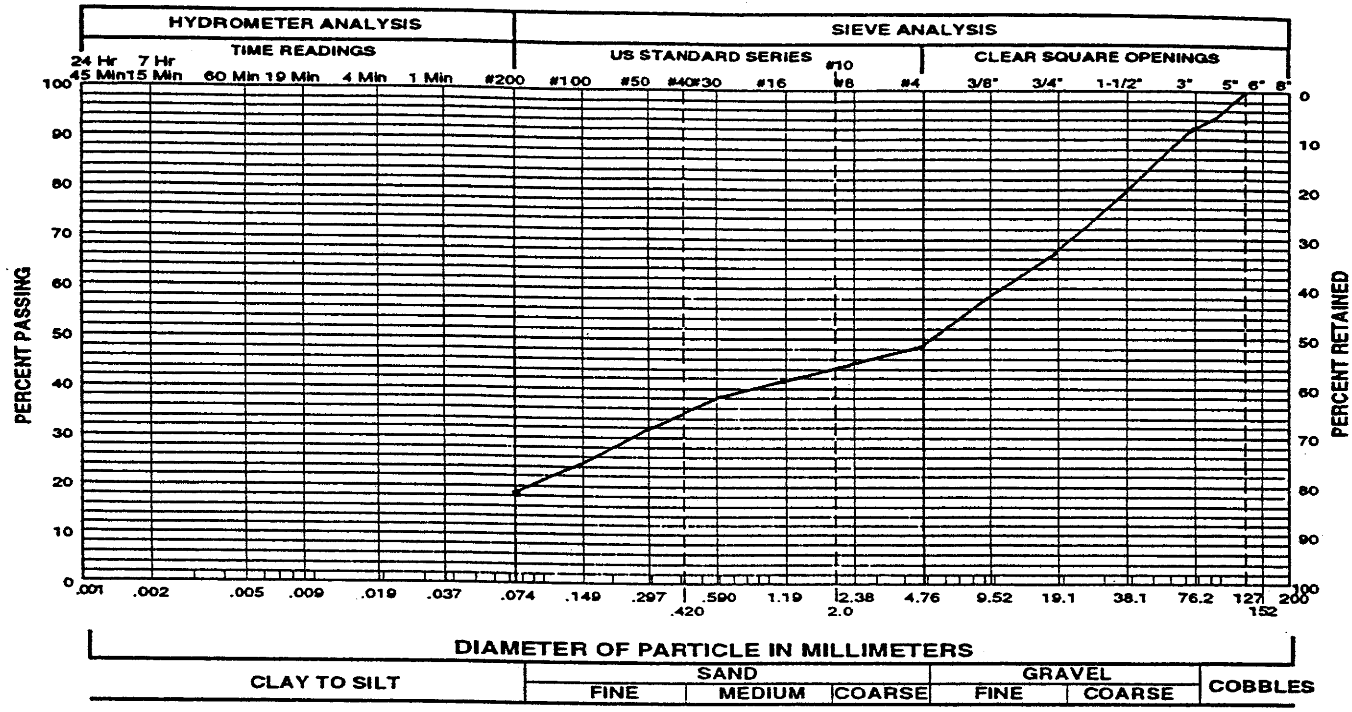
600 West Sandy Parkway • Sandy, Utah 84070 • (801) 566-6399 • FAX (801) 566-6493

APPLIED GEOTECHNICAL ENGINEERING CONSULTANTS, INC.

Table I. Summary of Laboratory Results

Sample Location	Gradation			Atterberg Limits		Sample Classification
	Gravel (%)	Sand (%)	Silt/ Clay (%)	Liquid Limit (%)	Plasticity Index (%)	
DCW-1 @ 0"-38"	52	30	18			Silty Gravel with Sand (GM)
DCW-3 @ 0"-26"	49	16	35	33	15	Clayey Gravel with Sand (GC)
DCW-6 @ 2.5'-6'	0	41	59			Sandy Silt (ML)
DCW-9 @ 0"-14"	0	15	85	26	9	Lean Clay with Sand (CL)
DCW-10 @ 13"-102"	34	34	32			Silty Sand with Gravel (SM)

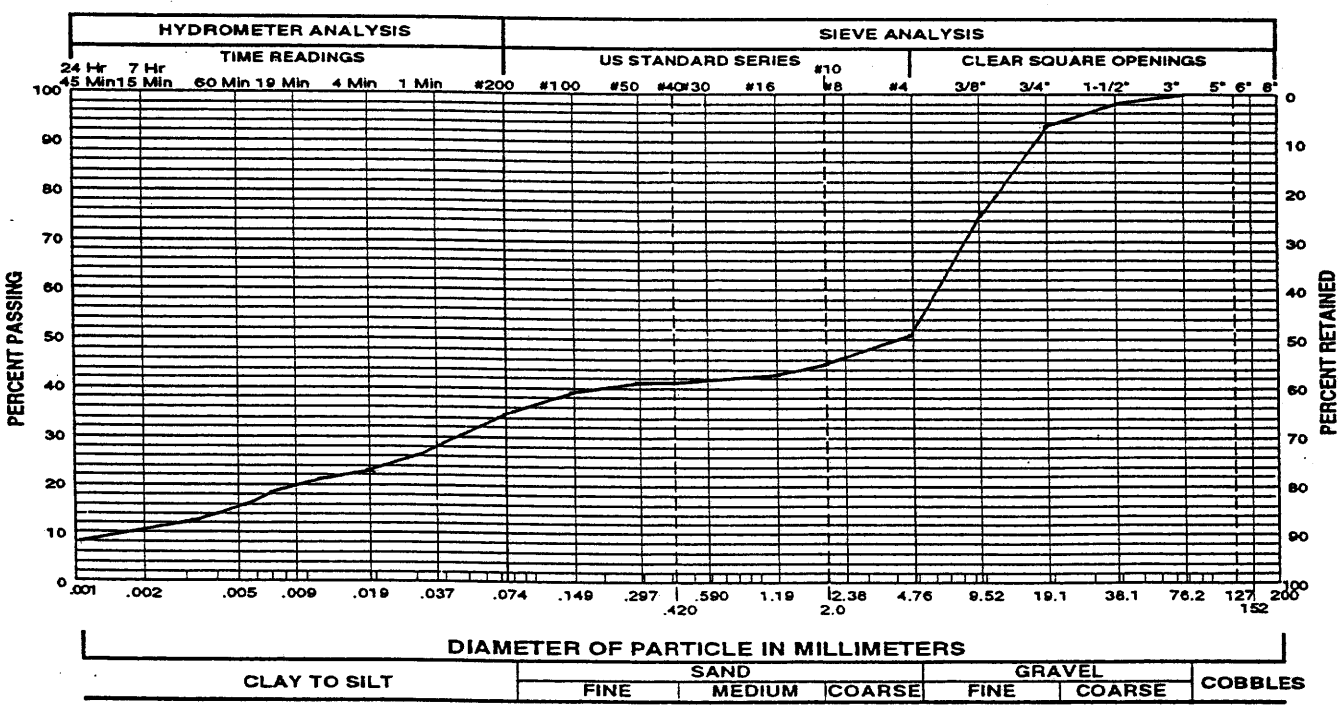
Applied Geotechnical Engineering Consultants, Inc.



Gravel 52 % Sand 30 % Silt and Clay 18 %

Liquid Limit ______ % Plasticity Index ______ %

Sample of Silty Gravel with Sand (GM) From Test Pit DCW-1 @ 0"-38"



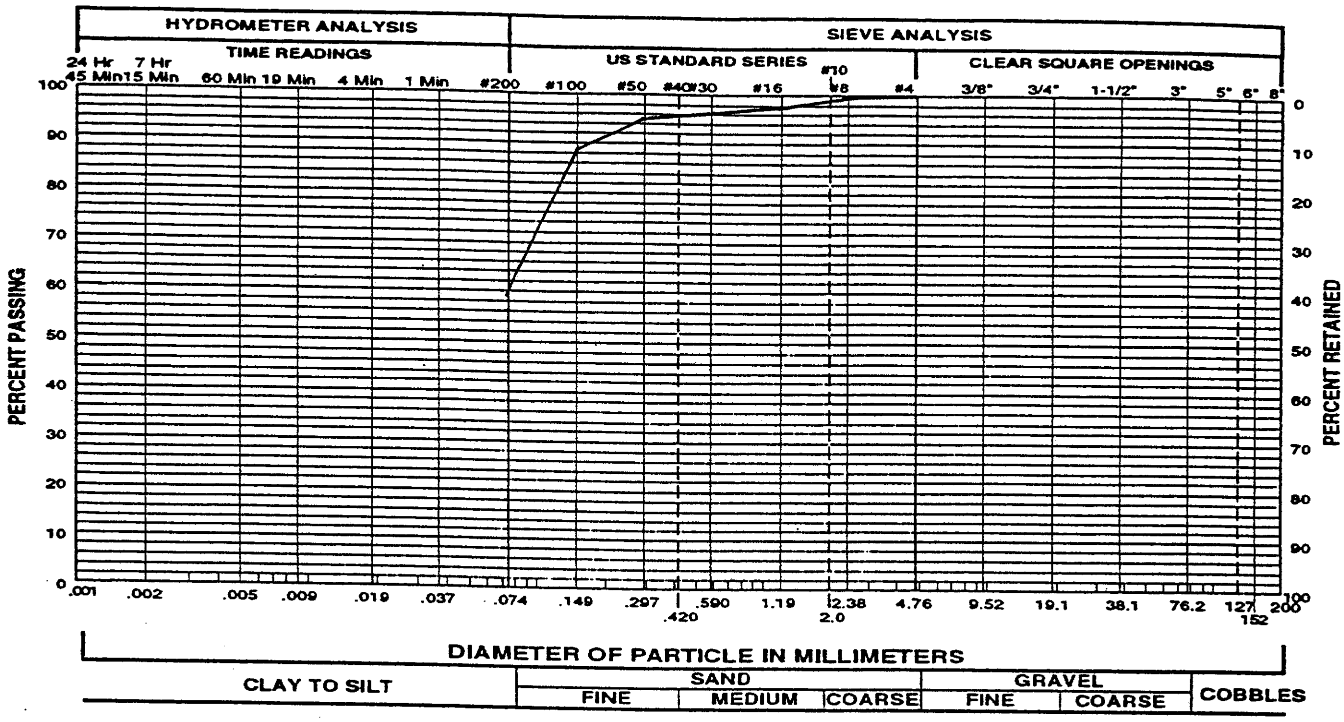
Gravel 49 % Sand 16 % Silt and Clay 35 %

Liquid Limit 33 % Plasticity Index 15 %

Sample of Clayey Gravel with Sand (GC) From Test Pit DCW-3 @ 0"-26"

Project No. 1990648 **GRADATION TEST RESULTS** Figure 1

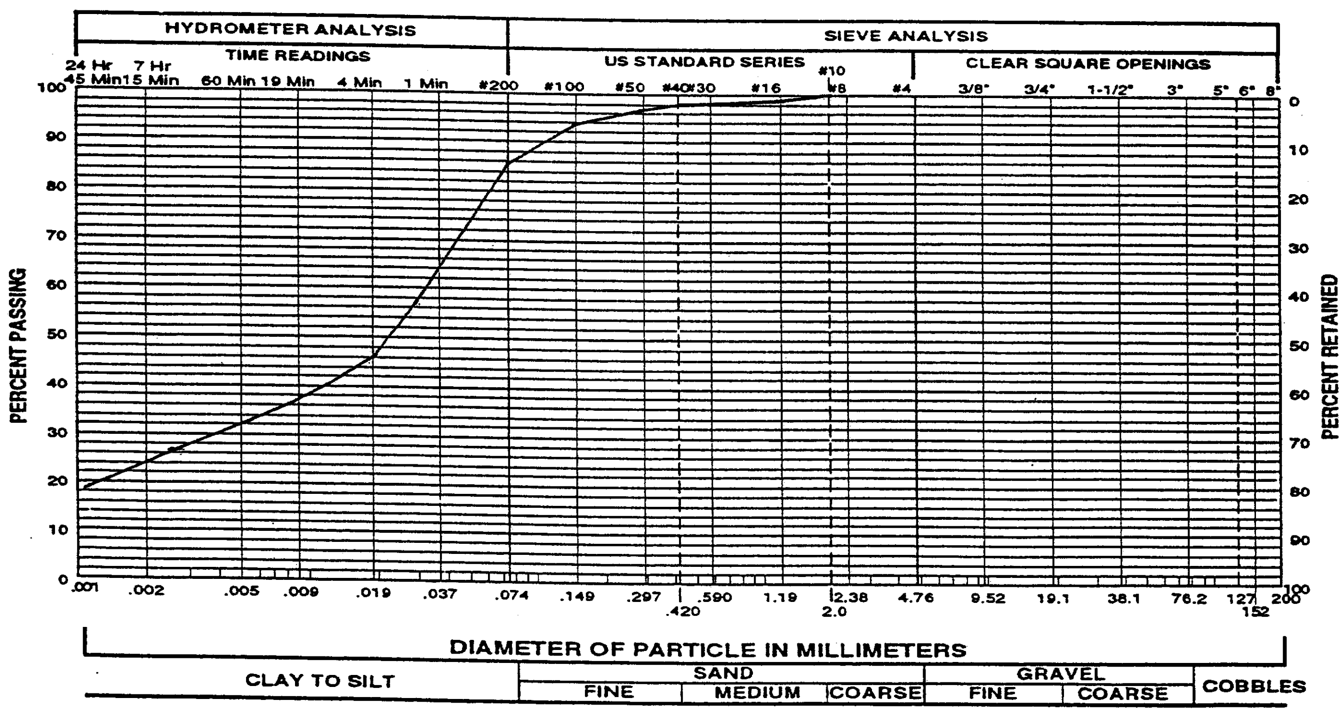
Applied Geotechnical Engineering Consultants, Inc.



Gravel 0 % Sand 41 % Silt and Clay 59 %

Liquid Limit ______ % Plasticity Index ______ %

Sample of Sandy Silt (ML) From Test Pit DCW-6 @ 2.5'-6'



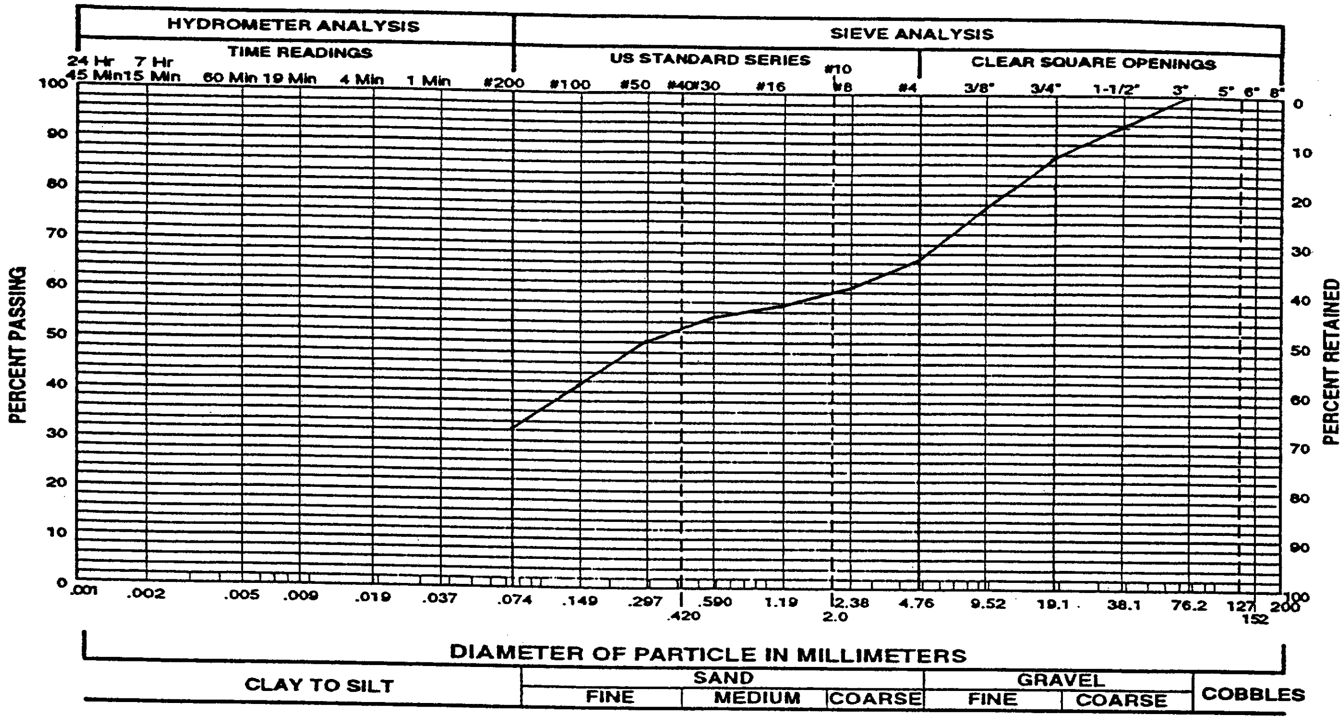
Gravel 0 % Sand 15 % Silt and Clay 85 %

Liquid Limit 26 % Plasticity Index 9 %

Sample of Lean Clay with Sand (CL) From Test Pit DCW-9 @ 0"-14"

Project No. 1990648 **GRADATION TEST RESULTS** Figure 2

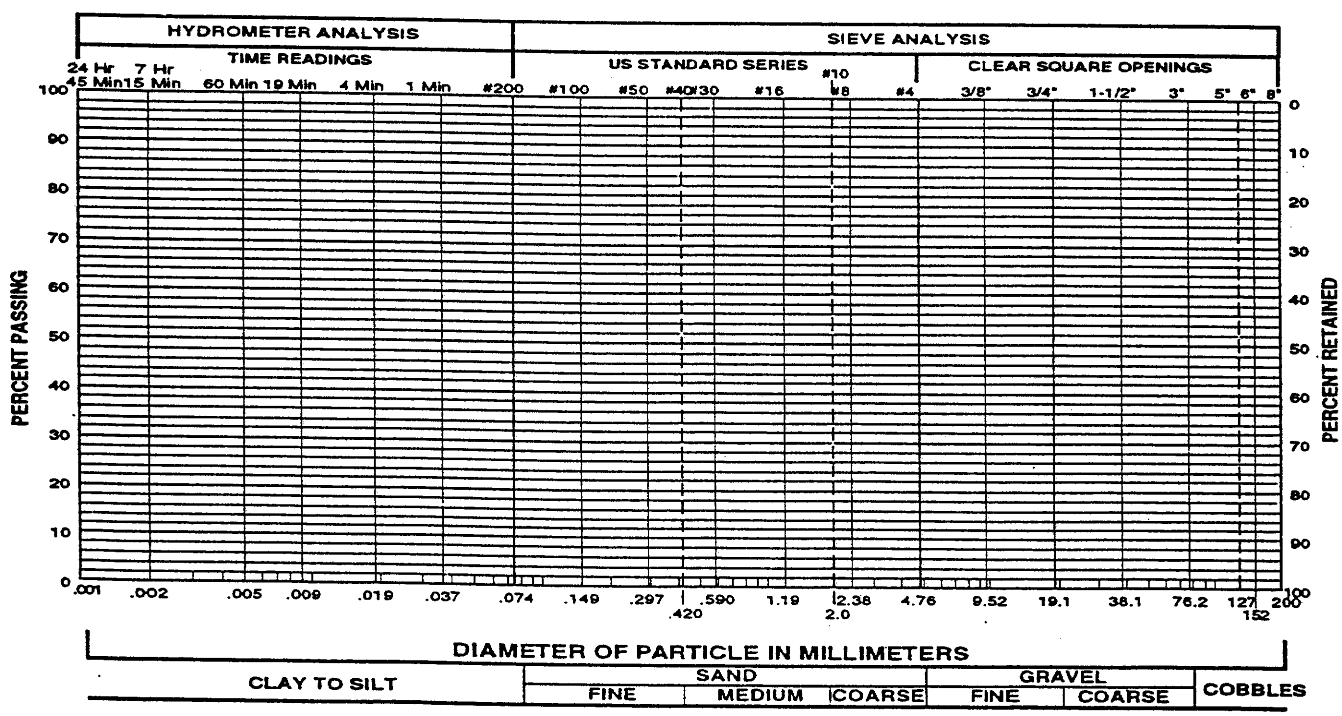
Applied Geotechnical Engineering Consultants, Inc.



Gravel 34 % Sand 34 % Silt and Clay 32 %

Liquid Limit ______ % Plasticity Index ______ %

Sample of Silty Sand with Gravel (SM) From Test Pit DCW-10 @ 13"-102"



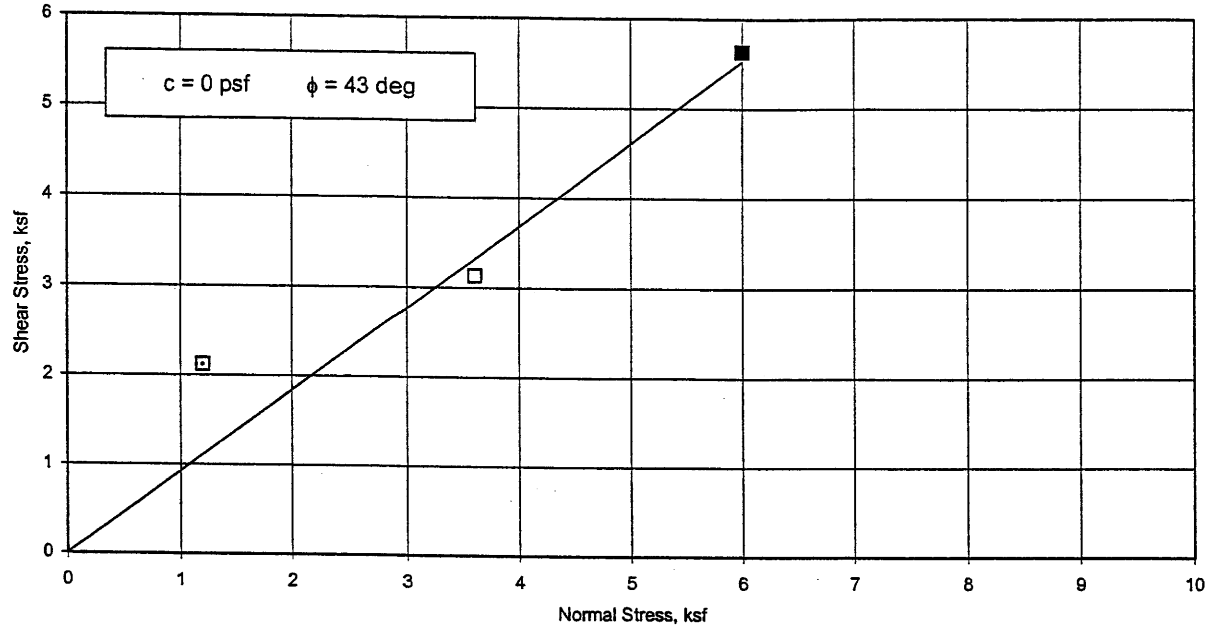
Gravel ______ % Sand ______ % Silt and Clay ______ %

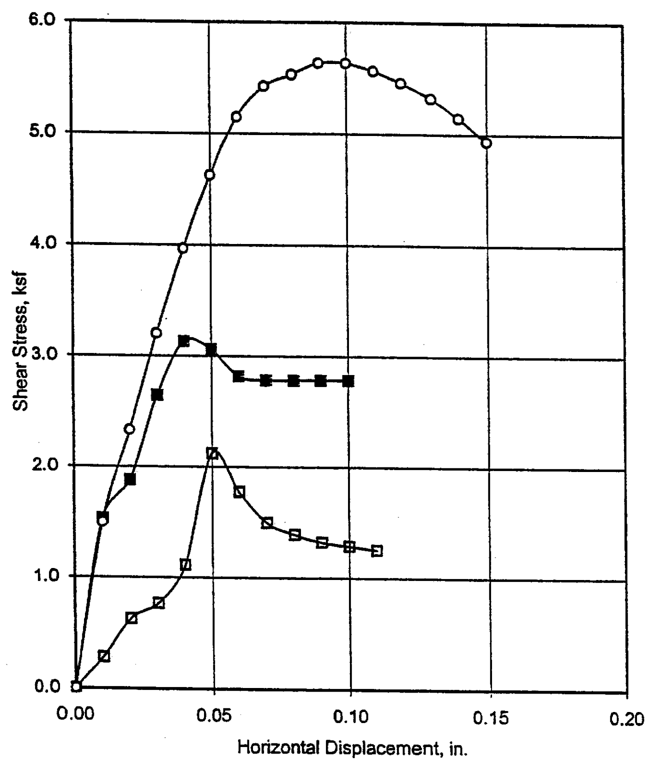
Liquid Limit ______ % Plasticity Index ______ %

Sample of ______ From ______

Project No. 1990648 **GRADATION TEST RESULTS** Figure 3

Applied Geotechnical Engineering Consultants, Inc.





Test No. (Symbol)	1(□)	2(■)	3(○)
Sample Type	Remolded		
Length, in.	1.00	1.00	1.00
Diameter, in.	1.93	1.93	1.93
Dry Density, pcf	115	115	115
Moisture Content, %	6	6	6
Consolidation Load, ksf	1.2	3.6	6.0
Normal Load, ksf	1.2	3.6	6.0
Shear Stress, ksf	2.12	3.13	5.64
Remarks	Strain Rate 0.05 in/min. Test performed on material passing the No. 4 sieve.		

Sample Index Properties	
Dry Density, pcf	N/A
Moisture Content, %	N/A
Liquid Limit, %	N/A
Plasticity Index, %	N/A
Percent Gravel	52
Percent Sand	30
Percent Passing No. 200 Sieve	18

Type of Test: Consolidated Undrained/Unsaturated

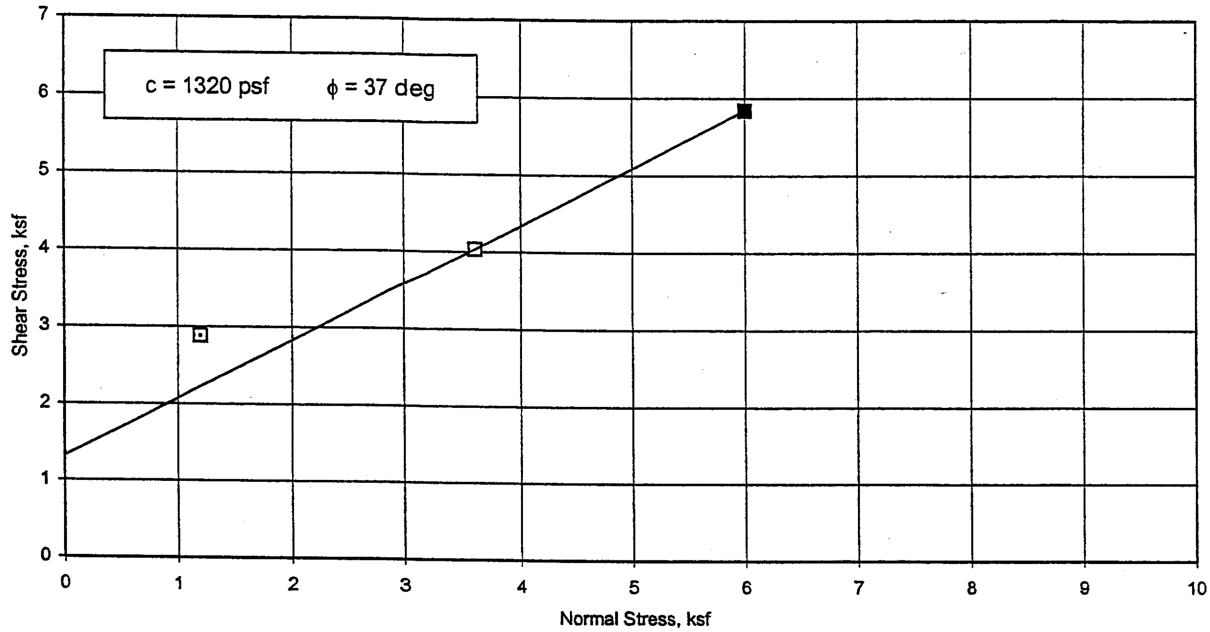
Sample Description: Silty Gravel with Sand (GM) From: Test Pit DCW-1 @ 0"-38"

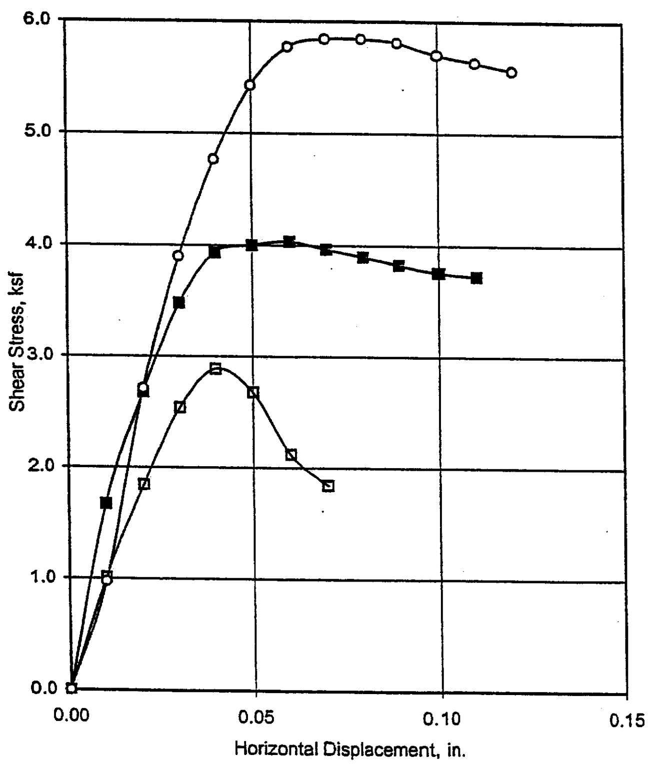
Project No. 1990648

DIRECT SHEAR TEST RESULTS

Figure 4

Applied Geotechnical Engineering Consultants, Inc.





Test No. (Symbol)	1(□)	2(■)	3(○)
Sample Type	Remolded		
Length, in.	1.00	1.00	1.00
Diameter, in.	1.93	1.93	1.93
Dry Density, pcf	113	113	113
Moisture Content, %	6	6	6
Consolidation Load, ksf	1.2	3.6	6.0
Normal Load, ksf	1.2	3.6	6.0
Shear Stress, ksf	2.89	4.04	5.85
Remarks	Strain Rate 0.05 in/min. Test performed on material passing the No. 4 sieve.		

Sample Index Properties	
Dry Density, pcf	N/A
Moisture Content, %	N/A
Liquid Limit, %	33
Plasticity Index, %	15
Percent Gravel	49
Percent Sand	16
Percent Passing No. 200 Sieve	35

Type of Test: Consolidated Undrained/Unsaturated

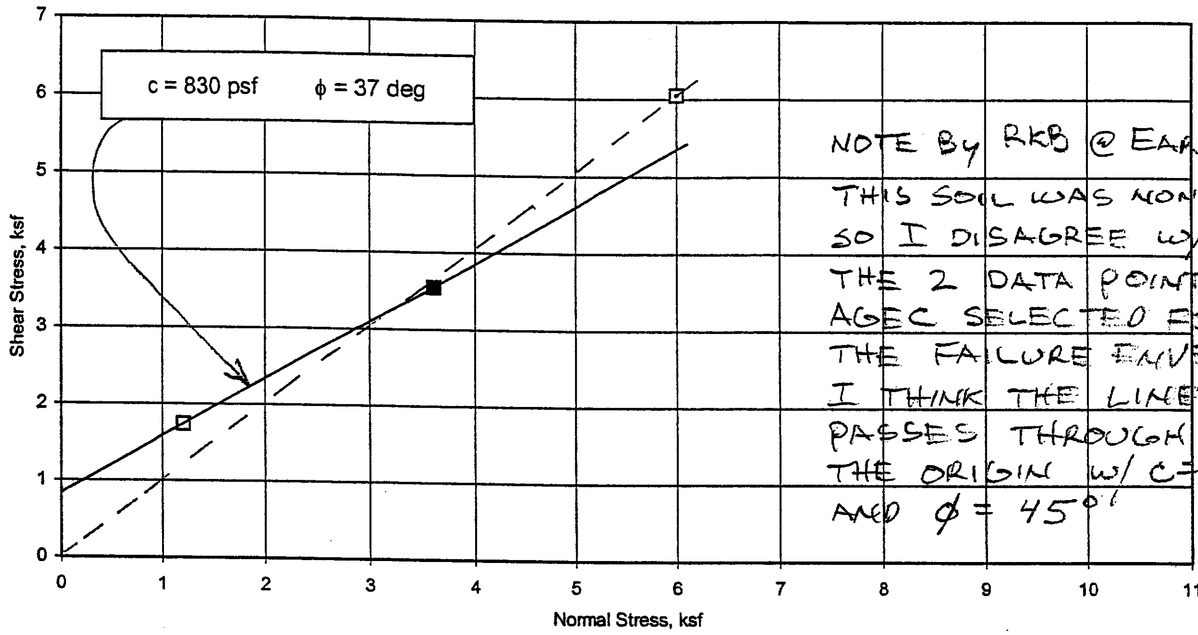
Sample Description: Clayey Gravel with Sand (GC) From Test Pit DCW-3 @ 0"-26"

Project No. 1990648

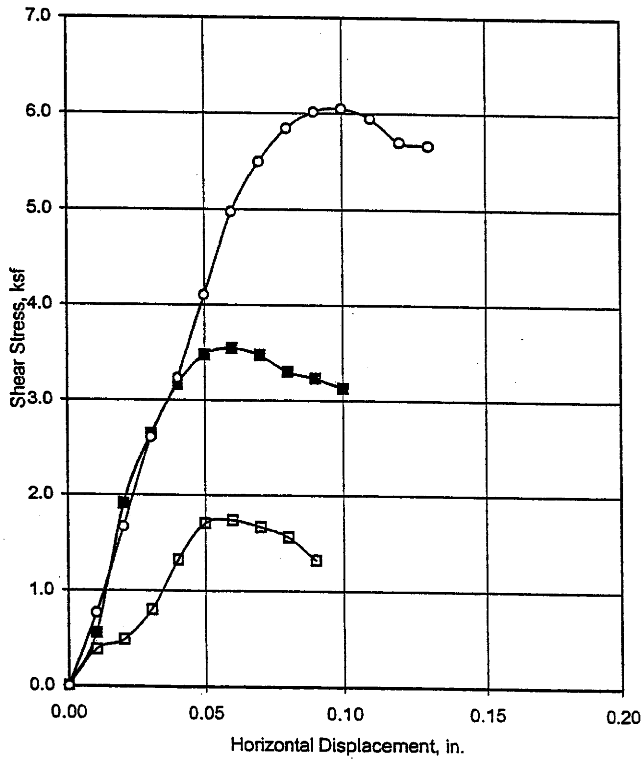
DIRECT SHEAR TEST RESULTS

Figure 5

Applied Geotechnical Engineering Consultants, Inc.



NOTE BY RKB @ EARTHFAX: THIS SOIL WAS NONCOHESIVE, SO I DISAGREE W/ THE 2 DATA POINTS AGEC SELECTED FOR THE FAILURE ENVELOPE. I THINK THE LINE PASSES THROUGH THE ORIGIN W/ C = 0 PSF AND ϕ = 45°.



Test No. (Symbol)	1(□)	2(■)	3(O)
Sample Type	Remolded		
Length, in.	1.00	1.00	1.00
Diameter, in.	1.93	1.93	1.93
Dry Density, pcf	112	112	112
Moisture Content, %	9	9	9
Consolidation Load, ksf	1.2	3.6	6.0
Normal Load, ksf	1.2	3.6	6.0
Shear Stress, ksf	1.74	3.55	6.05
Remarks	Strain Rate 0.05 in/min. Test performed on material passing the No. 4 sieve.		

Sample Index Properties	
Dry Density, pcf	N/A
Moisture Content, %	N/A
Liquid Limit, %	N/A
Plasticity Index, %	N/A
Percent Gravel	0
Percent Sand	41
Percent Passing No. 200 Sieve	59

Type of Test: Consolidated Undrained/Unsaturated

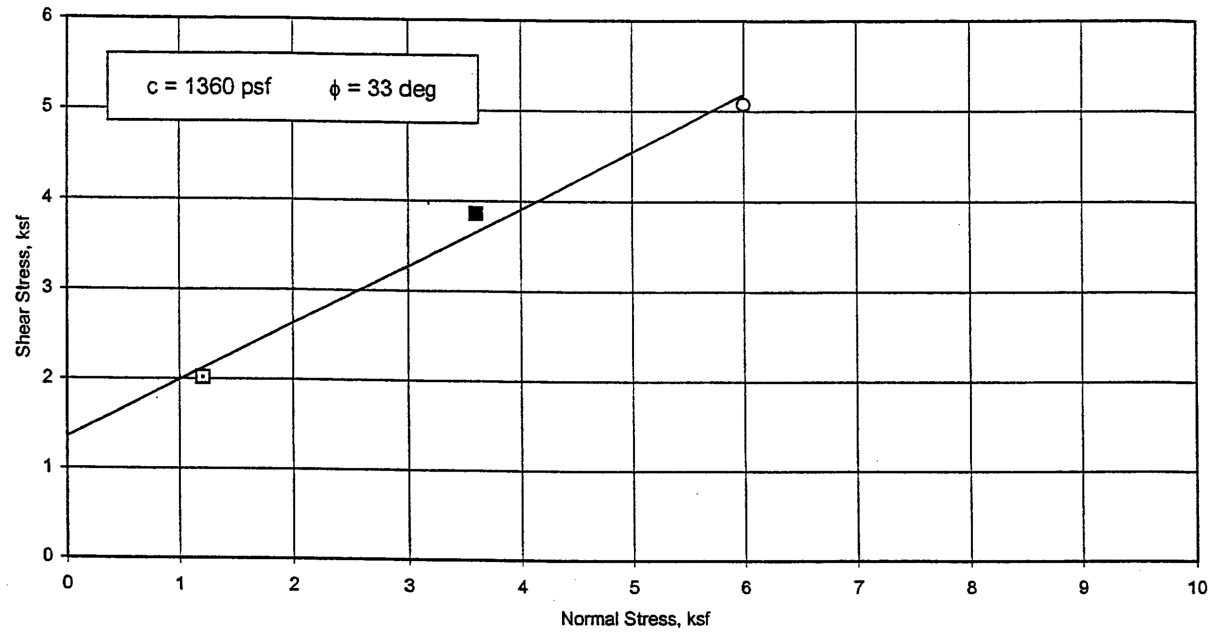
Sample Description: Sandy Silt (ML) From: Test Pit DCW-6 @ 2.5'-6'

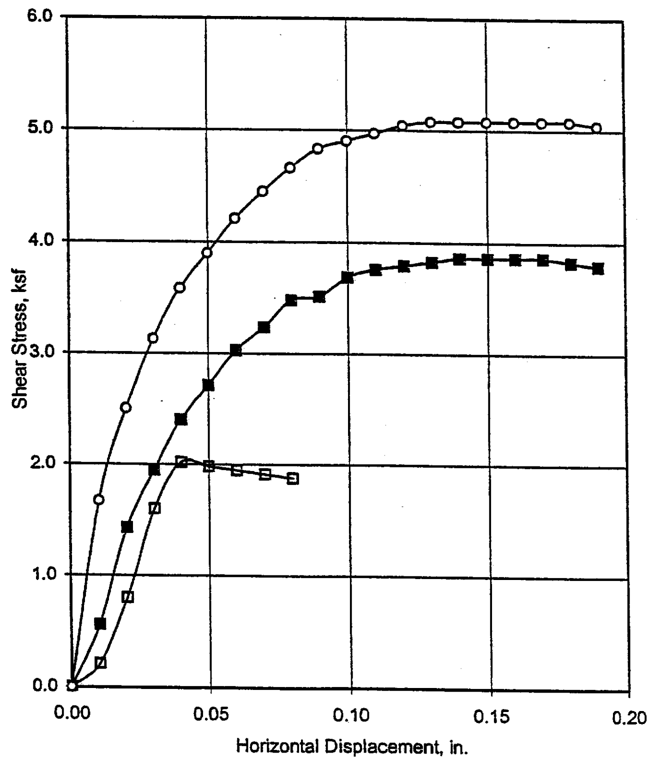
Project No. 1990648

DIRECT SHEAR TEST RESULTS

Figure 6

Applied Geotechnical Engineering Consultants, Inc.





Test No. (Symbol)	1(□)	2(■)	3(O)
Sample Type	Remolded		
Length, in.	1.00	1.00	1.00
Diameter, in.	1.93	1.93	1.93
Dry Density, pcf	98	98	98
Moisture Content, %	6	6	6
Consolidation Load, ksf	1.2	3.6	6.0
Normal Load, ksf	1.2	3.6	6.0
Shear Stress, ksf	2.02	3.86	5.08
Remarks	Strain Rate 0.05 in/min. Test performed on material passing the No. 4 sieve.		

Sample Index Properties	
Dry Density, pcf	N/A
Moisture Content, %	N/A
Liquid Limit, %	26
Plasticity Index, %	9
Percent Gravel	0
Percent Sand	15
Percent Passing No. 200 Sieve	85

Type of Test: Consolidated Undrained/Unsaturated

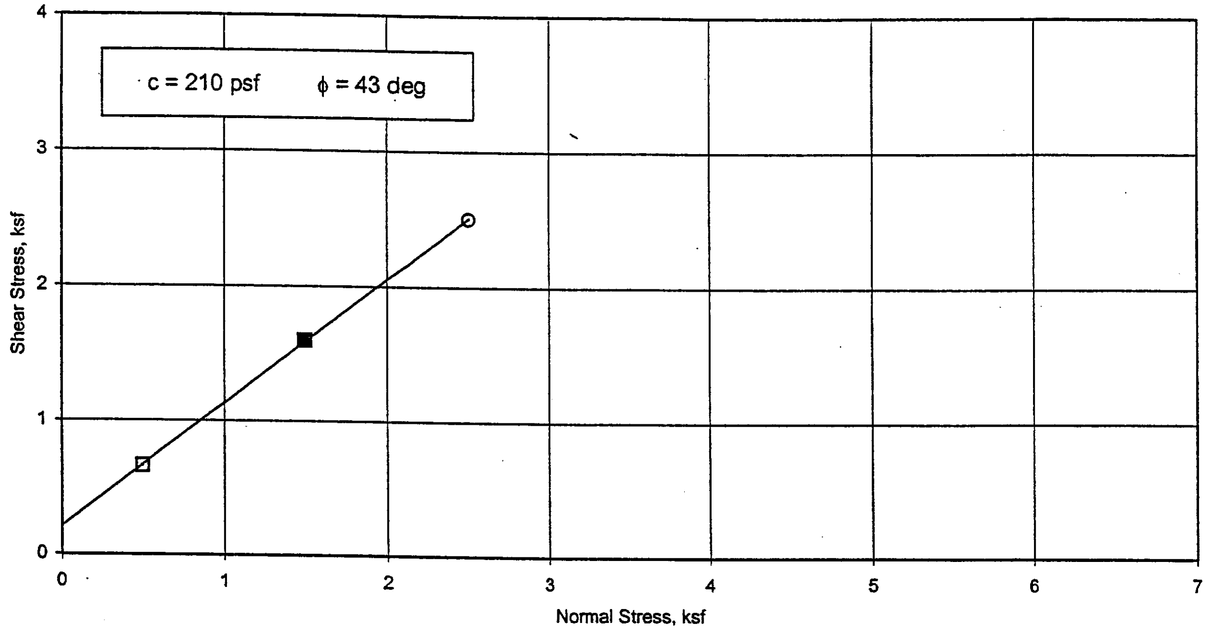
Sample Description: Lean Clay with Sand (CL) From: Test Pit DCW-9 @ 0"-14"

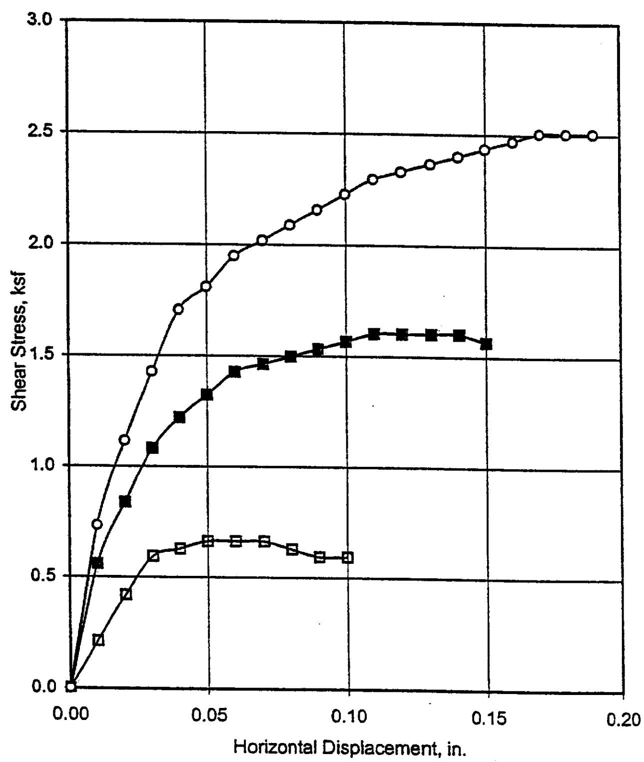
Project No. 1990648

DIRECT SHEAR TEST RESULTS

Figure 7

Applied Geotechnical Engineering Consultants, Inc.





Test No. (Symbol)	1(□)	2(■)	3(○)
Sample Type	Remolded		
Length, in.	1.00	1.00	1.00
Diameter, in.	1.93	1.93	1.93
Dry Density, pcf	100	100	100
Moisture Content, %	8	8	8
Consolidation Load, ksf	0.5	1.5	2.5
Normal Load, ksf	0.5	1.5	2.5
Shear Stress, ksf	0.66	1.60	2.51
Remarks	Strain Rate 0.05 in/min. Test performed on material passing the No. 4 sieve.		

Sample Index Properties	
Dry Density, pcf	N/A
Moisture Content, %	N/A
Liquid Limit, %	N/A
Plasticity Index, %	N/A
Percent Gravel	34
Percent Sand	34
Percent Passing No. 200 Sieve	32

Type of Test: Consolidated Undrained/Unsaturated

Sample Description: Silty Sand with Gravel (SM) From Test Pit DCW-10 @ 13"-102"

Project No. 1990648

DIRECT SHEAR TEST RESULTS

Figure 8

```
TITLE
DUGOUT CANYON WASTEROCK PILE
WORST CASE CONDITION
GRANULAR SOIL PROPERTY PARAMETERS
PROFIL
6 5
0 20 20 20 2
20 20 89 60 2
89 60 99 59 2
99 59 129 69 1
129 69 158 70 1
99 59 158 59 2
SOIL
2
110 120 490 35 0 0 0
115 125 0 43 0 0 0
CIRCL2
31 30 0 30 80 140 0 5 25 -30
END
```

```
***************************************************************
*****                                                    *****
*****                   GeoSlope                         *****
*****                 Version 5.00                       *****
*****                                                    *****
*****      (c)1992 by GEOCOMP Corp, Concord, MA          *****
*****       Licensed to EarthFax Engineering             *****
***************************************************************
```

Problem Title: DUGOUT CANYON WASTEROCK PILE
Description: WORST CASE CONDITION
Remarks: GRANULAR SOIL PROPERTY PARAMETERS

```
***************************************************************
*****                   INPUT DATA                       *****
***************************************************************
```

Profile Boundaries

Number of Boundaries: 6
Number of Top Boundaries: 5

Boundary No.	X-Left (ft)	Y-Left (ft)	X-Right (ft)	Y-Right (ft)	Soil Type Below Bnd
1	0.00	20.00	20.00	20.00	2
2	20.00	20.00	89.00	60.00	2
3	89.00	60.00	99.00	59.00	2
4	99.00	59.00	129.00	69.00	1
5	129.00	69.00	158.00	70.00	1
6	99.00	59.00	158.00	59.00	2

Soil Parameters

Number of Soil Types: 2

Soil Type No.	Total Unit Wt. (pcf)	Saturated Unit Wt. (pcf)	Cohesion Intercept (psf)	Friction Angle (deg)	Pore Pressure Param.	Pressure Constant (psf)	Piez. Surface No.
1	110.0	120.0	490.0	35.0	0.00	0.0	0
2	115.0	125.0	0.0	43.0	0.00	0.0	0

****
*****   TRIAL SURFACE GENERATION   *****
****

Data for Generating Circular Surfaces

Number of Initiation Points:	31
Number of Surfaces From Each Point:	30
Left Initiation Point:	0.00 ft
Right Initiation Point:	30.00 ft
Left Termination Point:	80.00 ft
Right Termination Point:	140.00 ft
Minimum Elevation:	0.00 ft
Segment Length:	5.00 ft
Positive Angle Limit:	25.00 deg
Negative Angle Limit:	-30.00 deg

****
*****   RESULTS   *****
****

Critical Surfaces

No.	Safety Factor	Center X (ft)	Center Y (ft)	Circle Radius (ft)
1	1.620	-141.74	391.97	404.76
2	1.620	-138.78	385.43	397.70
3	1.621	-125.01	354.10	364.08
4	1.656	-83.50	300.89	298.08
5	1.667	-181.96	481.44	503.08
6	1.672	-17.18	172.77	155.98
7	1.672	-15.58	167.29	150.57
8	1.685	-38.42	217.51	205.18
9	1.709	-64.69	271.83	265.24
10	1.710	6.97	136.37	113.31

```
TITLE
DUGOUT CANYON WASTEROCK PILE
WORST CASE CONDITION
MANCOS SHALE SOIL PROPERTY PARAMETERS
PROFIL
6 5
0 20 20 20 2
20 20 89 60 2
89 60 99 59 2
99 59 129 69 1
129 69 158 70 1
99 59 158 59 2
SOIL
2
110 120 490 35 0 0 0
115 125 1360 33 0 0 0
CIRCL2
31 30 0 30 80 150 0 5 25 -30
END
```

```
***************************************************************
*****                       GeoSlope                     *****
*****                     Version 5.00                   *****
*****                                                    *****
*****          (c)1992 by GEOCOMP Corp, Concord, MA      *****
*****          Licensed to EarthFax Engineering          *****
***************************************************************
```

Problem Title: DUGOUT CANYON WASTEROCK PILE
Description: WORST CASE CONDITION
Remarks: MANCOS SHALE SOIL PROPERTY PARAMETERS

```
***************************************************************
*****                      INPUT DATA                    *****
***************************************************************
```

Profile Boundaries

Number of Boundaries: 6
Number of Top Boundaries: 5

Boundary No.	X-Left (ft)	Y-Left (ft)	X-Right (ft)	Y-Right (ft)	Soil Type Below Bnd
1	0.00	20.00	20.00	20.00	2
2	20.00	20.00	89.00	60.00	2
3	89.00	60.00	99.00	59.00	2
4	99.00	59.00	129.00	69.00	1
5	129.00	69.00	158.00	70.00	1
6	99.00	59.00	158.00	59.00	2

Soil Parameters

Number of Soil Types: 2

Soil Type No.	Total Unit Wt. (pcf)	Saturated Unit Wt. (pcf)	Cohesion Intercept (psf)	Friction Angle (deg)	Pore Pressure Param.	Pressure Constant (psf)	Piez. Surface No.
1	110.0	120.0	490.0	35.0	0.00	0.0	0
2	115.0	125.0	1360.0	33.0	0.00	0.0	0

****
***** TRIAL SURFACE GENERATION *****
****

Data for Generating Circular Surfaces

Number of Initiation Points:	31
Number of Surfaces From Each Point:	30
Left Initiation Point:	0.00 ft
Right Initiation Point:	30.00 ft
Left Termination Point:	80.00 ft
Right Termination Point:	150.00 ft
Minimum Elevation:	0.00 ft
Segment Length:	5.00 ft
Positive Angle Limit:	25.00 deg
Negative Angle Limit:	-30.00 deg

****
***** RESULTS *****
****

Critical Surfaces

No.	Safety Factor	Center X (ft)	Center Y (ft)	Circle Radius (ft)
1	3.734	44.22	117.37	100.34
2	3.740	47.12	111.30	95.24
3	3.755	50.31	114.88	100.55
4	3.756	47.94	109.69	95.90
5	3.756	42.61	133.62	117.17
6	3.758	48.35	124.29	109.81
7	3.759	38.81	132.99	114.89
8	3.761	46.42	126.40	112.14
9	3.765	39.91	137.07	119.69
10	3.765	46.64	137.03	120.73

```
TITLE
DUGOUT CANYON WASTEROCK PILE
WORST CASE CONDITION
WASTE ROCK PILE ONLY
PROFIL
6 5
0 20 20 20 2
20 20 89 60 2
89 60 99 59 2
99 59 129 69 1
129 69 158 70 1
99 59 158 59 2
SOIL
2
110 120 490 35 0 0 0
115 125 1360 33 0 0 0
CIRCL2
22 30 89 110 120 150 0 3 25 -30
END
```

```
**********************************************************************
*****                         GeoSlope                           *****
*****                       Version 5.00                         *****
*****                                                            *****
*****           (c)1992 by GEOCOMP Corp, Concord, MA             *****
*****              Licensed to EarthFax Engineering              *****
**********************************************************************
```

Problem Title: DUGOUT CANYON WASTEROCK PILE
Description: WORST CASE CONDITION
Remarks: WASTE ROCK PILE ONLY

```
**********************************************************************
*****                        INPUT DATA                          *****
**********************************************************************
```

Profile Boundaries

Number of Boundaries: 6
Number of Top Boundaries: 5

Boundary No.	X-Left (ft)	Y-Left (ft)	X-Right (ft)	Y-Right (ft)	Soil Type Below Bnd
1	0.00	20.00	20.00	20.00	2
2	20.00	20.00	89.00	60.00	2
3	89.00	60.00	99.00	59.00	2
4	99.00	59.00	129.00	69.00	1
5	129.00	69.00	158.00	70.00	1
6	99.00	59.00	158.00	59.00	2

Soil Parameters

Number of Soil Types: 2

Soil Type No.	Total Unit Wt. (pcf)	Saturated Unit Wt. (pcf)	Cohesion Intercept (psf)	Friction Angle (deg)	Pore Pressure Param.	Pressure Constant (psf)	Piez. Surface No.
1	110.0	120.0	490.0	35.0	0.00	0.0	0
2	115.0	125.0	1360.0	33.0	0.00	0.0	0

****
***** TRIAL SURFACE GENERATION *****
****

Data for Generating Circular Surfaces

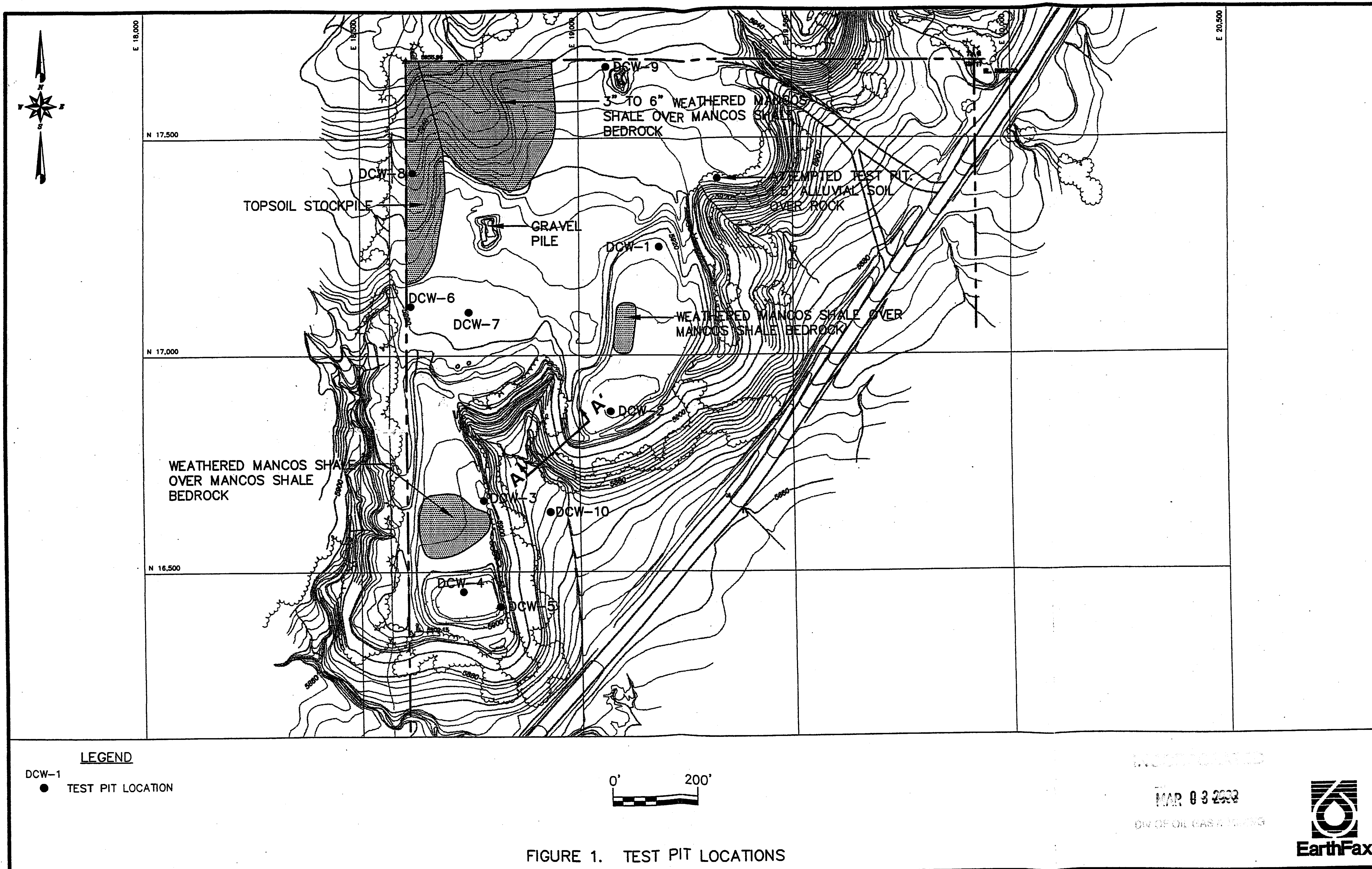
Number of Initiation Points:	22
Number of Surfaces From Each Point:	30
Left Initiation Point:	89.00 ft
Right Initiation Point:	110.00 ft
Left Termination Point:	120.00 ft
Right Termination Point:	150.00 ft
Minimum Elevation:	0.00 ft
Segment Length:	3.00 ft
Positive Angle Limit:	25.00 deg
Negative Angle Limit:	-30.00 deg

****
***** RESULTS *****
****

Critical Surfaces

No.	Safety Factor	Center X (ft)	Center Y (ft)	Circle Radius (ft)
1	7.477	109.69	89.39	30.38
2	7.517	109.90	98.03	38.84
3	7.529	113.70	82.31	23.02
4	7.544	115.46	80.94	21.77
5	7.573	114.71	94.62	35.60
6	7.760	116.34	88.50	29.07
7	7.792	116.45	89.12	29.69
8	7.880	105.18	108.73	49.66
9	7.979	116.76	77.68	17.97
10	8.045	114.15	76.32	17.06

G:\UC698\11\DWG\FIG-1TP.DWG 10-28-99



MAR 0 3 2000

DIV OF OIL GAS & MINING

EarthFax

FIGURE 1. TEST PIT LOCATIONS

EarthFax

EarthFax
Engineering Inc
Engineers/Scientists
7324 So. Union Park Ave.
Suite 100
Midvale, Utah 84047
Telephone 801-561-1555
Fax 801-561-1861

November 10, 1999

Mr. Chris Hansen
Canyon Fuel Company, LLC
Dugout Canyon Mine
HC35 Box 380
Helper, Utah 84526

Subject: Results of a foundation investigation for the proposed waste-rock pile at the Dugout Canyon Mine

Dear Chris:

The purpose of this letter is to present the results of a foundation investigation for the proposed waste-rock pile at the Dugout Canyon Mine near Wellington, Utah. The proposed waste-rock pile is located about 4.5 miles southwest of the mine. The project was conducted in general accordance with the proposal from EarthFax dated September 8, 1999 except as noted below:

1. Only local areas with small quantities of weathered Mancos Shale were encountered. Therefore, only 2 series of laboratory tests (Atterberg Limits, gradation, hydrometer, and direct shear) were conducted on weathered Mancos Shale samples, rather than the three that were proposed.

2. Gradation and direct shear tests were conducted on samples of granular alluvium and silty sand from the site to provide soil strength parameters for all of the native soils.

3. Nine test pits were installed to investigate the different soil types, rather than the proposed six test pits.

4. One additional test pit was excavated near the proposed location of a sedimentation pond embankment for the waste-rock pile. Gradation and direct shear tests were conducted on a sample from this test pit. The data are presented in this report, but slope stability analyses were not conducted for the sedimentation pond embankment.

SOILS INFORMATION

The site was originally investigated by RB&G Engineering, Inc. (1998; Provo, Utah) as a potential borrow source for granular fill used at the Dugout Canyon Mine. The results of that investigation indicated that the soils consisted of interbedded layers of gravel and clay overlying Mancos Shale. Following removal and stockpiling of the topsoil, the soils were excavated, crushed, screened, and transported to the Dugout Canyon Mine. The excavation typically continued until Mancos Shale was encountered. As a result, the remaining soil consisted primarily of remnants of granular alluvium and weathered Manco Shale.

Nine shallow test pits identified as DCW-1 through DCW-9 were excavated using a rubber tire backhoe within the footprint of the proposed waste-rock pile. One test pit was excavated near the proposed location of a sedimentation pond embankment for the waste-rock pile. The locations of the test pits are presented in Figure 1 (attached). The test pits were logged by a geotechnical engineer from EarthFax and by a soil scientist from EIS, Inc. (Salt Lake City, Utah). EarthFax's test pit logs are attached. Nuclear density/moisture tests were conducted on the surface soils at most of the test pits to provide remolding criteria for samples submitted for direct shear tests. Select samples were submitted to Applied Geotechnical Engineering Consultants, Inc. (Sandy, Utah) for geotechnical laboratory analyses.

According to the test pit logs, a thin layer (2 to 2.2 feet thick) of weathered Mancos Shale over Mancos Shale bedrock was encountered at Test Pits DCW-3 and DCW-9. Remnants (2.7 to 9 feet thick) of gravelly sand alluvium were encountered at Test Pits DCW-1, DCW-2, DCW-4, DCW-5. Mancos Shale was encountered below the alluvial soil at Test Pits DCW-1 and DCW-4. Test Pit DCW-6 contained layers of silty sand and sandy silt to a depth of 6 feet overlying alluvium to a depth of 7.5 feet. At Test Pit DCW-7, some coal, sandstone gravel, and soil extended to a depth of 0.7 feet, silty sand alluvium extended to a depth of 6 feet, and gravelly sand alluvium extended to a depth of about 7 feet. Stockpiled topsoil was encountered to a depth of 5 feet at Test Pit DCW-8, under which a gravelly sand alluvium extended to a depth of 6.5 feet. At the location of the proposed sedimentation pond embankment (Test Pit DCW-10), the subsurface soils consisted of a silty sand topsoil to a depth of 1.1 feet over a gravelly sand layer to a depth of 8.5 feet.

Results of the laboratory analyses are attached and are summarized in Table 1. Direct shear tests were conducted on samples that were remolded to the same dry density and moisture contents that were recorded in the field from the nuclear density/moisture tests. From Table 1:

- **Weathered Mancos Shale (Test Pits DCW-3 and DCW-9):** The material contained 0 to 49% gravel, 15 to 16% sand, 25 to 61% silt, and 10 to 24% clay. According to the Atterberg Limits data, the liquid limit was 26 to 33, the plastic limit was 17 to 18, and the plastic index was 9 to 15. The angle of internal friction ranged between 33 and 37 degrees, and the cohesion intercept values ranged between 1320 and 1360 pounds per square foot ("psf"). The direct shear tests were conducted under consolidated, undrained, unsaturated (moist) conditions.

- **Gravelly Sand Alluvium (Test Pit DCW-1):** The material contained 52% gravel, 30% sand, and 18% silt. The angle of internal friction was 43 degrees and the soil was noncohesive from direct shear tests conducted under consolidated, undrained, unsaturated (moist) conditions.

- **Sandy Silt (Test Pit DCW-6):** The material contained 59% silt and 41% sand. The angle of internal friction was 45 degrees. and the soil was noncohesive from direct shear tests conducted under consolidated, undrained, unsaturated (moist) conditions.

- **Sedimentation Pond Embankment Subgrade (Test Pit DCW-10):** The material contained 34% gravel, 34% sand, and 32% silt. The angle of internal friction was 43 degrees and the cohesion intercept value was 210 psf from direct shear tests conducted under consolidated, undrained, unsaturated (moist) conditions.

WASTE-ROCK

The waste-rock to be placed at the site will originate as roof-fall and other rock materials being cleaned from the Dugout Canyon Mine. Similar waste-rock had been tested for a slope stability analysis of a temporary waste-rock pile at the Dugout Canyon Mine. The results of this analysis were presented in a letter dated July 27, 1998 from EarthFax Engineering to Canyon Fuel Company. As part of that investigation, gradation, Atterberg Limits, Standard Proctor compaction, and direct shear tests were conducted on the waste-rock. Results of these analyses are attached (data sheets dated July 15, 1998). According to these analyses, the waste-rock is coarse-grained, with about 95% retained on the No. 200 sieve (i.e., sand fraction or larger), and about 82% retained on the No. 4 sieve (i.e., gravel fraction). The material has further been classified as poorly-graded, with a Unified Soil Classification of GP-GM. The sample had an angle of internal friction of 35 degrees and a cohesion strength of 490 pounds per square foot. These strength parameters will be used for the slope stability analysis of the proposed waste-rock pile.

ASSUMPTIONS

The following assumptions were made for the slope stability analyses:

1. The waste-rock will be placed to a maximum thickness of 60 feet with a maximum outslope of 2 horizontal to 1 vertical (27 degrees).

2. As a worst-case condition, the native soil is vertically continuous and the failure surfaces do not intersect the Mancos Shale bedrock. This assumption was included because the Mancos Shale bedrock surface is variable.

3. The soil property parameters used for the analyses are representative of the native soils throughout the site. In the interest of conservatism, the weakest

soils from the direct shear tests were used for the analyses, which were as follows (see Table 1):

	Granular Soil	Weathered Mancos Shale
Angle of Internal Friction (degrees)	43	33
Cohesive Strength (psf)	0	1360

4. The soils do not become saturated, and there is no phreatic surface. The soils drain rapidly, and excess pore pressures do not develop in response to strains and stress changes.

5. The results of direct shear tests on the waste-rock presented in the letter dated July 27, 1998 from EarthFax Engineering to Canyon Fuel Company are representative of the proposed waste-rock pile. Therefore, the angle of internal friction is 35 degrees and the cohesive strength is 490 pounds per square foot.

RESULTS

Slope stability analyses were performed using the computer program GEOSLOPE (Version 5.0). GEOSLOPE utilizes the limit equilibrium procedure of slices (Simplified Bishop's method) to determine the safety factor of potential failure surfaces for circular shapes.

Prior to conducting the analyses, the topography of the native slope in Figure 1 was studied to determine the most critical slopes. The steepest native slopes occur along the southern end of the west edge of the property, where sections of the slope are about 30 to 40 degrees, although the slope lengths are relatively short. The longest native slopes occur along the eastern edge of the property, but the slope angles in this area are only 15 to 20 degrees. Intermediate slope angles and lengths are present in the vicinity of Test Pit DCW-10. Sections from all three of these areas were analyzed, and the results indicated that the most critical slopes occurred along the southern end of the west edge of the property. Therefore, the analysis cross-section for this project is presented as Section A-A' in Figure 1.

Using the assumptions presented above, results of the slope stability analyses are attached and are summarized in Table 2 (attached). The results of the stability analyses include the data files, the output files, and the cross-sections that show the trial failure surfaces and the ten critical failure surfaces. Table 2 includes a description of the analysis slope, the number of trial failure surfaces, and the safety factor against sliding. From Table 2, the critical safety factor was 1.59 for failure surfaces originating at the toe of the native slope (alluvial soil) and terminating in the waste-rock pile. When soil strength parameters for weathered Mancos Shale were used for the native soils, the safety factor increased to 2.38. The critical safety factor was 2.27 for failure surfaces originating and terminating in the waste-rock pile. These values satisfy the minimum regulatory requirement of 1.5 promulgated by the Utah Division of Oil, Gas, and Mining (R645-301-536.110). Because the effects of bedrock were not included in the analyses, the results are considered to be conservative.

We have appreciated the opportunity to provide this information. If you have any questions, please call.

Sincerely,

Rhett Brooks

Rhett Brooks, P.E.
EarthFax Engineering, Inc.

cc: Richard White, EarthFax
Tom Suchoski, EarthFax

REGISTERED PROFESSIONAL ENGINEER
92-187704-2202
RHETT K.
BROOKS
STATE OF UTAH

Rhett Brooks

Nov. 10, 1999

REFERENCES

RB&G Engineering, Inc. 1998. Canyon Fuel Company, Dugout Canyon Surface Coal Handling Facilities near Wellington, Utah. Project report dated June 1998 prepared for Canyon Fuel Company. Provo, Utah.

Utah Division of Oil, Gas, and Mining. 1996. Utah Coal Mining Regulations. Salt Lake City, Utah.

TABLE 1

SUMMARY OF LABORATORY TEST RESULTS

Test Pit and Depth (Ft.)	Gradation (%)				Atterberg Limits			Direct Shear Test Values	
	Gravel	Sand	Silt	Clay	Liquid Limit	Plastic Index	Plastic Limit	Cohesive Strength (psf)	Angle of Internal Friction (degrees)
DCW-1 0-3.2[a]	52	30	18		--	--	--	0	43
DCW-3 0-2.2[b]	49	16	25	10	33	15	18	1320	37
DCW-6 2.5-6[c]	0	41	59		--	--	--	0	45
DCW-9 0-1.2[d]	0	15	61	24	26	9	17	1360	33
DCW-10 1.1-8.5[e]	34	34	32		--	--	--	210	43

(a) Alluvium. Sample for direct shear test remolded to a dry density of 115 pcf at a moisture content of 6%, which were the results of a nuclear density/moisture test conducted on the ground surface near the test pit. Direct shear test conducted under consolidated-undrained (CU) unsaturated conditions with vertical effective pressures of 1200, 3600, and 6000 psf.

(b) Weathered Mancos Shale. Direct shear test samples remolded to a dry density of 113 pcf at a moisture content of 6%, which were the results of a nuclear tests conducted on the ground surface near the test pit. Direct shear test conducted under consolidated-undrained (CU) unsaturated conditions with vertical effective pressures of 1200, 3600, and 6000 psf.

(c) Silty sand. Sample for direct shear test remolded to a dry density of 112 pcf at a moisture content of 9%, which were the results of a nuclear density/moisture test conducted on the ground surface near the test pit. Direct shear test conducted under consolidated-undrained (CU) unsaturated conditions with vertical effective pressures of 1200, 3600, and 6000 psf.

(d) Weathered Mancos Shale. Direct shear test samples remolded to a dry density of 98 pcf at a moisture content of 6%, which were the results of a nuclear test conducted on the ground surface near the test pit. Direct shear test conducted under consolidated-undrained (CU) unsaturated conditions with vertical effective pressures of 1200, 3600, and 6000 psf.

(e) Silty Sand at proposed location of a sedimentation pond embankment. Direct shear test samples remolded to a dry density of 100 pcf at a moisture content of 8%, which were the results of a nuclear test conducted on the ground surface near the test pit. Direct shear test conducted under consolidated-undrained (CU) unsaturated conditions with vertical effective pressures of 500, 1500, and 2500 psf.

TABLE 2

RESULTS OF SLOPE STABILITY ANALYSES

Slope	Number of Trial Failure Surfaces	Safety Factor
Native Soil (Alluvium) and Waste-Rock Pile	6200	1.59
Native Soil (Mancos Shale) and Waste-Rock Pile	6200	2.38
Waste-Rock Pile	6000	2.27

G:\UC698\11\DWG\FIG-1TP.DWG 10-28-99

FIGURE 1. TEST PIT LOCATIONS

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TEST PIT DCW-1
(Excavated and logged on September 16, 1999)

Depth (ft.)	Description
0 - 3.2	Sandy Gravel w/ Silt and Cobbles. Alluvium. About 42% gravel, 30% sand, 10% cobbles, and 18% silt. Sand is typically fine to coarse grained. Cobbles are up to 7 inches in diameter, subround. Gravel is subround to subangular. Moist. No cementation or cohesion. Good foundation material or fill material. From a 12-inch nuclear density/moisture test: moisture content = 5.7%, dry density = 115.5 pounds per cubic foot, wet density = 122.1 pounds per cubic foot. Brown 10YR 4/3. GM.
3.2 - 4.6	Mancos Shale Bedrock. Fractured. Gray. Hard to dig.

TEST PIT DCW-2
(Excavated and logged on September 16, 1999)

Depth (ft.)	Description
0 - 7.7	Gravelly Sand w/ Silt, Cobbles, and Boulders. Alluvium. About 45% sand, 25% gravel, 15% cobbles/boulders, and 15% silt. Sand is typically fine to coarse grained. Gravel is subround to subangular. Moist. No cementation or cohesion. Good foundation material or fill material. From a 8-inch nuclear density/moisture test: moisture content = 7.8%, dry density = 115.0 pounds per cubic foot, wet density = 124.0 pounds per cubic foot. Brown 10YR 4/3. Boulders at bottom impeded digging deeper. SM.

TEST PIT DCW-3
(Excavated and logged on September 16, 1999)

Depth (ft.)	Description
0 - 2.2	Weathered Mancos Shale. 49% gravel (fractured Mancos Shale), 16% sand, 25% silt, and 10% clay. Loose in top 3 inches, firmer and less weathered with depth. From a 12-inch nuclear density/moisture test: moisture content = 5.6%, dry density = 112.6 pounds per cubic foot, wet density = 118.8 pounds per cubic foot.
2.2 - 3.2	Mancos Shale Bedrock. Fractured and slightly weathered. Gray. Hard to dig.

TEST PIT DCW-4
(Excavated and logged on September 16, 1999)

Depth (ft.)	Description
0 - 2.7	Gravelly Sand w/ Silt. Alluvium. About 55% sand, 20% gravel, 10% cobbles, and 15% silt. Sand is typically fine to coarse grained. Cobbles are up to 7 inches in diameter, subround. Gravel is subround to subangular. Moist. No cementation or cohesion. Good foundation material or fill material. From a 12-inch nuclear density/moisture test: moisture content = 5.7%, dry density = 115.5 pounds per cubic foot, wet density = 122.1 pounds per cubic foot. Brown 10YR 4/3. SM.
2.7 - 3.2	Mancos Shale Bedrock. Fractured. Gray. Hard to dig.

TEST PIT DCW-5
(Excavated and logged on September 16, 1999)

Depth (ft.)	Description
0 - 9	Gravelly Sand w/ Silt. Alluvium. About 55% sand, 20% gravel, 10% cobbles, and 15% silt. Sand is typically fine to coarse grained. Cobbles are up to 7 inches in diameter, subround. Gravel is subround to subangular. Moist. No cementation or cohesion. Good foundation material or fill material. From a 12-inch nuclear density/moisture test: moisture content = 5.7%, dry density = 115.5 pounds per cubic foot, wet density = 122.1 pounds per cubic foot. Brown 10YR 4/3. SM.

TEST PIT DCW-6
(Excavated and logged on September 16, 1999)

Depth (ft.)	Description
0 - 1.5	Silty Sand. About 60% sand and 40% silt. Sand is very fine to fine grained. Nonplastic. Numerous large roots from pine trees. From a 12-inch nuclear density/moisture test: moisture content = 8.8%, dry density = 102.9 pounds per cubic foot, wet density = 111.9 pounds per cubic foot. Yellowish brown 10YR 5/4. SM.
1.5 - 2.5	Sandy Silt. About 65% silt and 35% silt. Sand is very fine grained. Low plasticity, somewhat cohesive. Dry and hard. Very friable. ML.
2.5 - 6	Sandy Silt. About 59% silt and 41% sand. Sand is very fine grained. Nonplastic. Probably a blow sand layer. Light yellowish brown 2.5Y 6/3. ML.
6 - 7.5	Gravelly Sand w/ Silt. Alluvium. About 55% sand, 20% gravel, 10% cobbles/boulders, and 15% silt. Sand is typically fine to coarse grained. Gravel is subround to subangular. Moist. No cementation or cohesion. Brown 10YR 4/3. SM.

TEST PIT DCW-7
(Excavated and logged on September 16, 1999)

Depth (ft.)	Description
0 - 0.7	Mix of Rubbish. Mix of coal, sandstone, and dark brown soil (silt through cobbles). SM.
0.7 - 6	Silty Sand w/ Gravel. Alluvium. About 70% sand, 10% gravel/cobbles, 20% silt. Sand is typically fine to coarse grained. Gravel is subround to subangular. Moist. No cementation or cohesion. Brown 10YR 4/3. SM.
6 - 7	Gravelly Sand w/ Silt. Alluvium. About 55% sand, 20% gravel, 10% cobbles, and 15% silt. Sand is typically fine to coarse grained. Gravel is subround to subangular. Moist. No cementation or cohesion. Brown 10YR 4/3. SM.

TEST PIT DCW-8
Topsoil Stockpile
(Excavated and logged on September 16, 1999)

Depth (ft.)	Description
0 - 5	Topsoil Stockpile. Topsoil that had been stripped from the site and piled in this area. Primarily silty sand with gravel and organic matter.
5 - 6.5	Gravelly Sand w/ Silt. Alluvium. About 55% sand, 20% gravel, 10% cobbles, and 15% silt. Sand is typically fine to coarse grained. Gravel is subround to subangular. Moist. No cementation or cohesion. Brown 10YR 4/3. SM.

TEST PIT DCW-9
(Excavated and logged on September 16, 1999)

Depth (ft.)	Description
0 - 2	Weathered Mancos Shale. 61% silt, 24% clay, and 15% sand. Loose in top 14 inches, firmer and less weathered with depth. From a 12-inch nuclear density/moisture test: moisture content = 5.7%, dry density = 98.3 pounds per cubic foot, wet density = 103.8 pounds per cubic foot. CL.
2 - 2.5	Mancos Shale Bedrock. Fractured and slightly weathered. Gray. Hard to dig.

TEST PIT DCW-10
Near Proposed Sedimentation Pond Embankment
(Excavated and logged on September 16, 1999)

Depth (ft.)	Description
0 - 1.1	Silty Sand Topsoil. About 75% sand and 25% silt. Sand is very fine to fine grained. Nonplastic. Numerous fine roots. From a 12-inch nuclear density/moisture test: moisture content = 8.2%, dry density = 95.9 pounds per cubic foot, wet density = 103.7 pounds per cubic foot. Brown 10YR 4/3. SM.
1.1 - 8.5	Gravelly Sand w/ Silt. Alluvium. About 34% sand, 34% gravel/cobbles, and 32% silt. Sand is typically fine to coarse grained. Gravel is subround to subangular. Moist. No cementation or cohesion. Brown 10YR 4/3. SM.

AGEC

Applied Geotechnical Engineering Consultants, Inc.

July 15, 1998

TESTS CONDUCTED FOR SLOPE STABILITY ANALYSES OF A TEMPORARY WASTE-ROCK PILE AT THE DUGOUT CANYON MINE. RESULTS PRESENTED IN A LETTER DATED JULY 27, 1998, FROM EARTHFAX ENGINEERING TO CANYON FUEL COMPANY. RKB

Earthfax Engineering
7324 South 1300 East, Suite 100
Midvale, UT 84047

Attention: Richard B. White

Subject: Soils Laboratory Testing
AGEC Project No. 973301

Gentlemen:

Applied Geotechnical Engineering Consultants, Inc. was requested to provide laboratory testing on a sample received July 2, 1998. The following tests have been performed in general accordance with the test method listed.

Test	Test Method
Particle Size Analysis	ASTM D-422
Atterberg Limits	ASTM D-4318
Direct Shear	ASTM D-3080
Standard Proctor	ASTM D-698

The results of the laboratory testing are shown graphically in Figures 1-2. The direct shear test specimens were remolded to approximately 90% of the standard proctor maximum dry density near optimum moisture content. Only material passing the #4 sieve was used in direct shear testing.

If you have any questions, or if we can be of further service, please call.

Sincerely,

APPLIED GEOTECHNICAL ENGINEERING CONSULTANTS, INC.

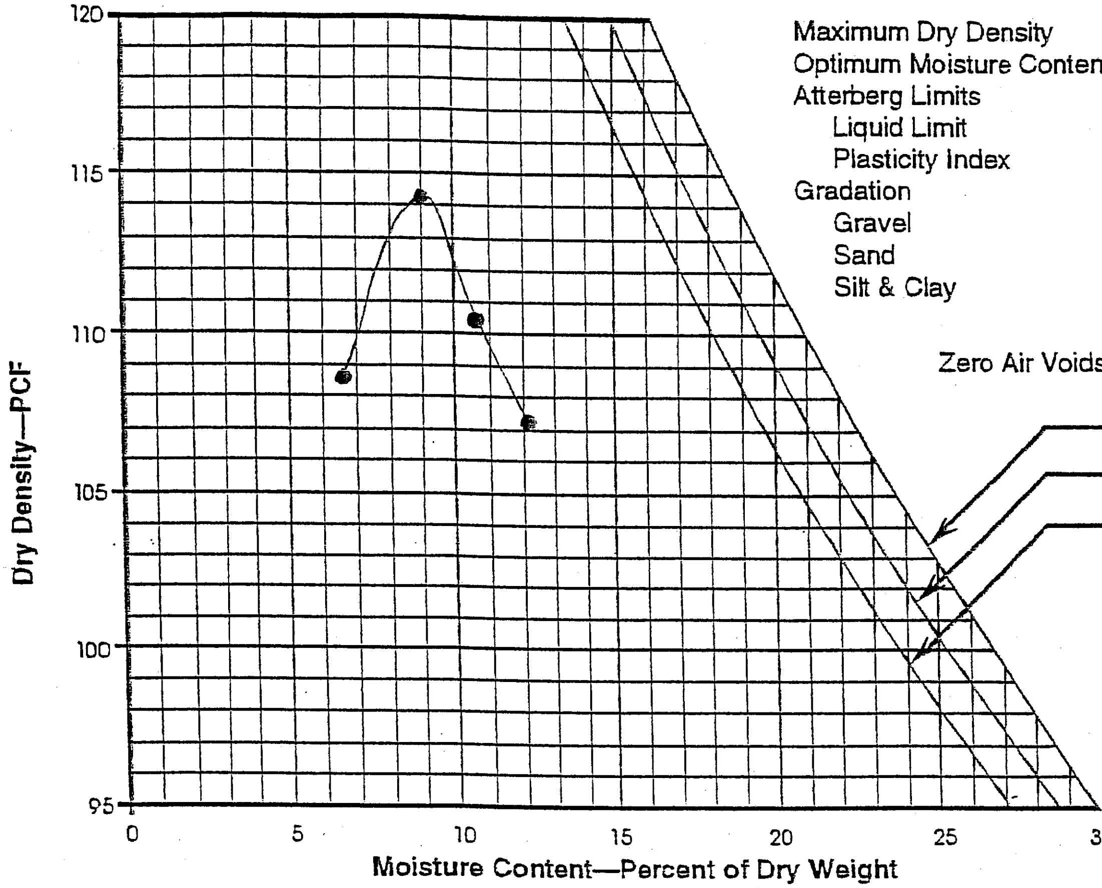
Stephanie Francom

Stephanie Francom
Rev. SDA, E.I.T.

OCT 11 2006

600 West Sandy Parkway • Sandy, Utah 84070 • (801) 566-6399 • FAX (801) 566-6493

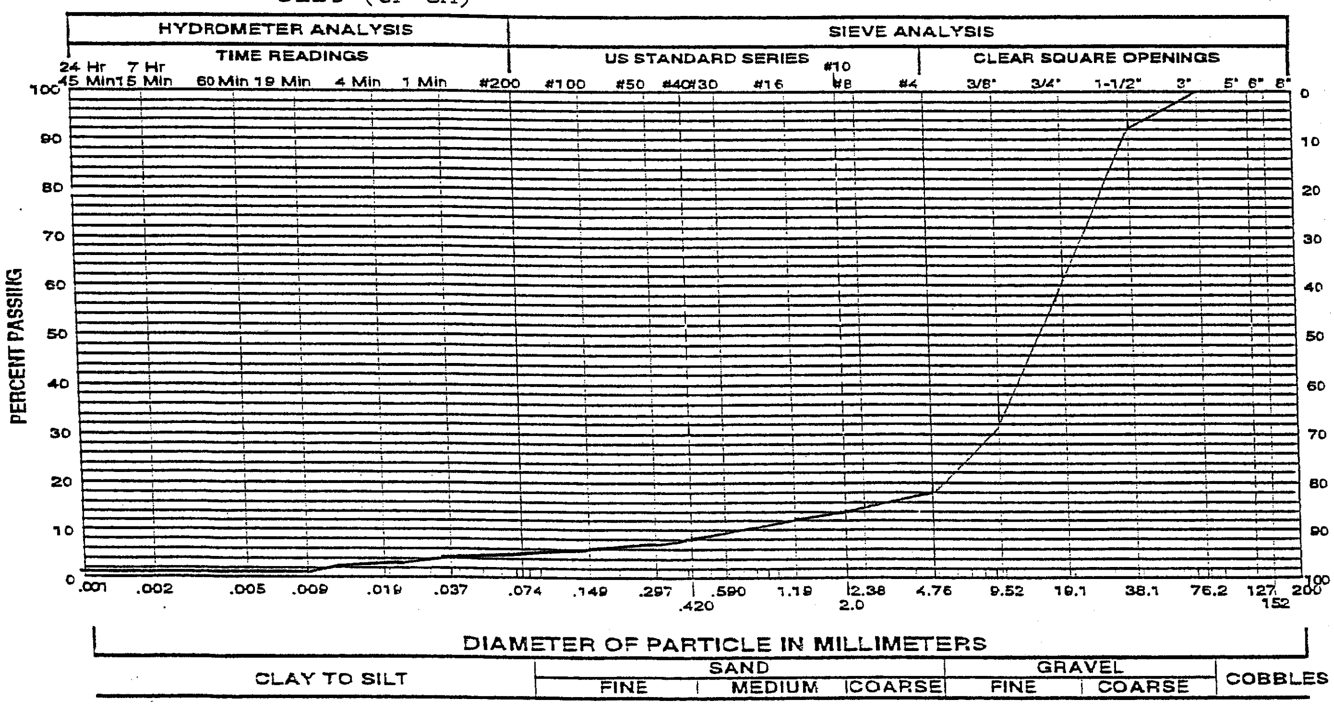
Applied Geotechnical Engineering Consultants, Inc.



Maximum Dry Density	114.0	pcf
Optimum Moisture Content	9.0	%
Atterberg Limits		
Liquid Limit	30	%
Plasticity Index	6	%
Gradation		
Gravel	82	%
Sand	13	%
Silt & Clay	5	%

Compaction Test Procedure ASTM D-698 Method D

Sample of: Poorly-Graded Gravel with Silt (GP-GM) From: DCM-1 (7/6/98)



GRADATION & COMPACTION TEST RESULTS

Project No. 973301

Figure 1

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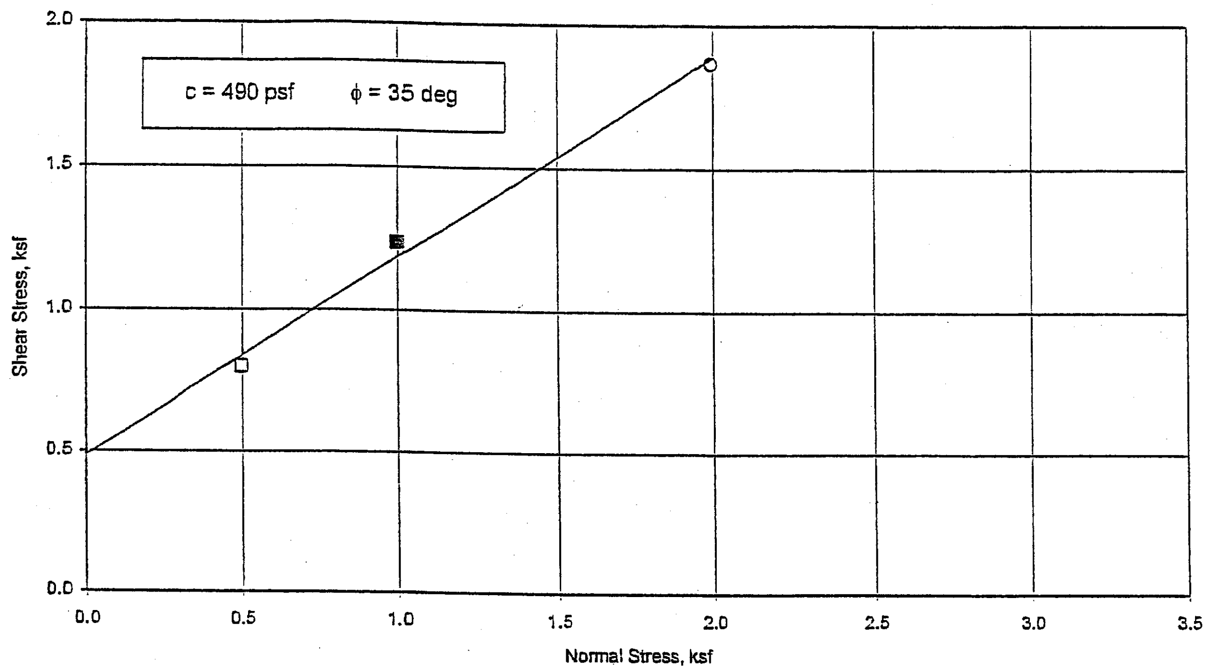
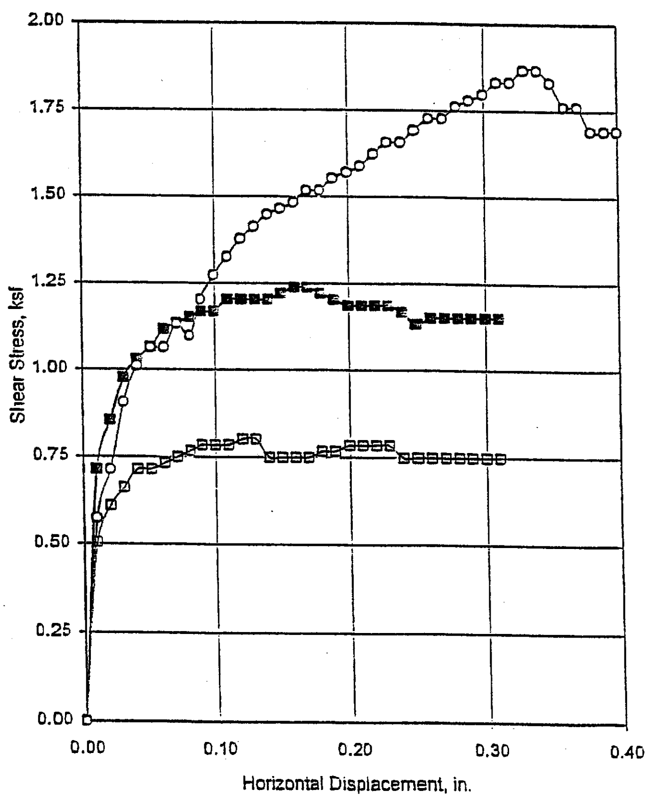
Applied Geotechnical Engineering Consultants, Inc.





Test No. (Symbol)	1(□)	2(■)	3(○)
Sample Type	Remolded		
Length, in.	0.75	0.75	0.75
Diameter, in.	1.93	1.93	1.93
Dry Density, pcf	112	112	112
Moisture Content, %	9	9	9
Consolidation Load, ksf	0.5	1.0	2.0
Normal Load, ksf	0.5	1.0	2.0
Shear Stress, ksf	0.80	1.24	1.87
Remarks	Strain Rate 0.05 in/min.		
	Only soil passing the #4 sieve was used in test.		

Sample Index Properties	
Dry Density, pcf	N/A
Moisture Content, %	N/A
Liquid Limit, %	30
Plasticity Index, %	6
Percent Gravel	82
Percent Sand	13
Percent Passing No. 200 Sieve	5

OCT 11 2006

Type of Test: Consolidated Undrained/Saturated

Sample Description: Poorly Graded Gravel with Silt (GP-GM) From DCM-1

Project No. 973301 **DIRECT SHEAR TEST RESULTS** Figure 2

Applied Geotechnical Engineering Consultants, Inc.

October 19, 1999

Earthfax Engineering
7324 South 1300 East, Suite 100
Midvale, UT 84047

Attention: Rhett Brooks

Subject: Soil Testing for Waste Rock Pile Foundation Investigation
Dugout Canyon, Utah
AGEC Project No. 1990648

Gentlemen:

Applied Geotechnical Engineering Consultants, Inc. was requested to provide laboratory testing on five bucket samples delivered to our laboratory September 17, 1999. The following tests were performed in general accordance with the test methods listed.

Test	Test Method
Particle Size Analysis	ASTM D 422
Atterberg Limits	ASTM D 4318
Direct Shear	ASTM D 3080

The results of the laboratory testing are summarized in Table I and shown graphically in Figures 1 through 8.

If you have any questions, or if we can be of further service, please call.

Sincerely,

APPLIED GEOTECHNICAL ENGINEERING CONSULTANTS, INC.

Stephanie Merkley

Stephanie Merkley

Reviewed by SDA, E.I.T.

OCT 1 1 2006

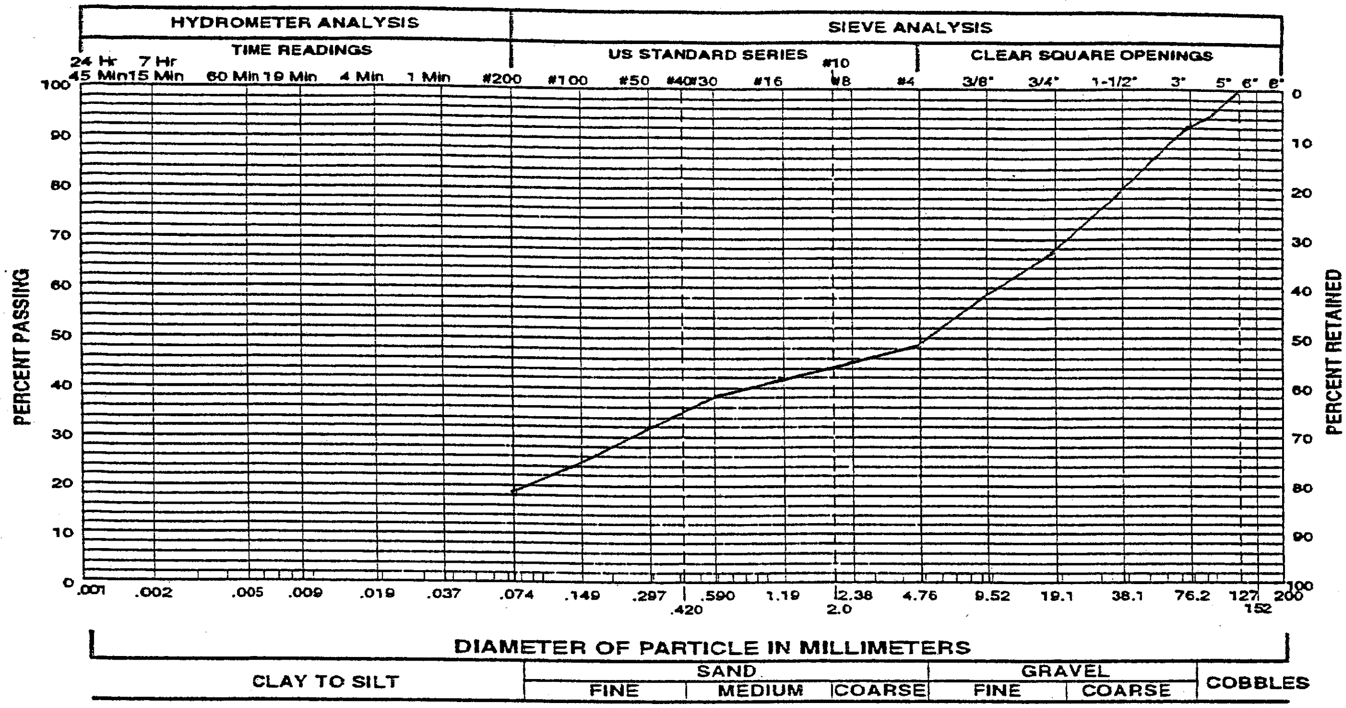
600 West Sandy Parkway • Sandy, Utah 84070 • (801) 566-6399 • FAX (801) 566-6493

APPLIED GEOTECHNICAL ENGINEERING CONSULTANTS, INC.

Table I. Summary of Laboratory Results

Sample Location	Gradation			Atterberg Limits		Sample Classification
	Gravel (%)	Sand (%)	Silt/ Clay (%)	Liquid Limit (%)	Plasticity Index (%)	
DCW-1 @ 0"-38"	52	30	18			Silty Gravel with Sand (GM)
DCW-3 @ 0"-26"	49	16	35	33	15	Clayey Gravel with Sand (GC)
DCW-6 @ 2.5'-6'	0	41	59			Sandy Silt (ML)
DCW-9 @ 0"-14"	0	15	85	26	9	Lean Clay with Sand (CL)
DCW-10 @ 13"-102"	34	34	32			Silty Sand with Gravel (SM)

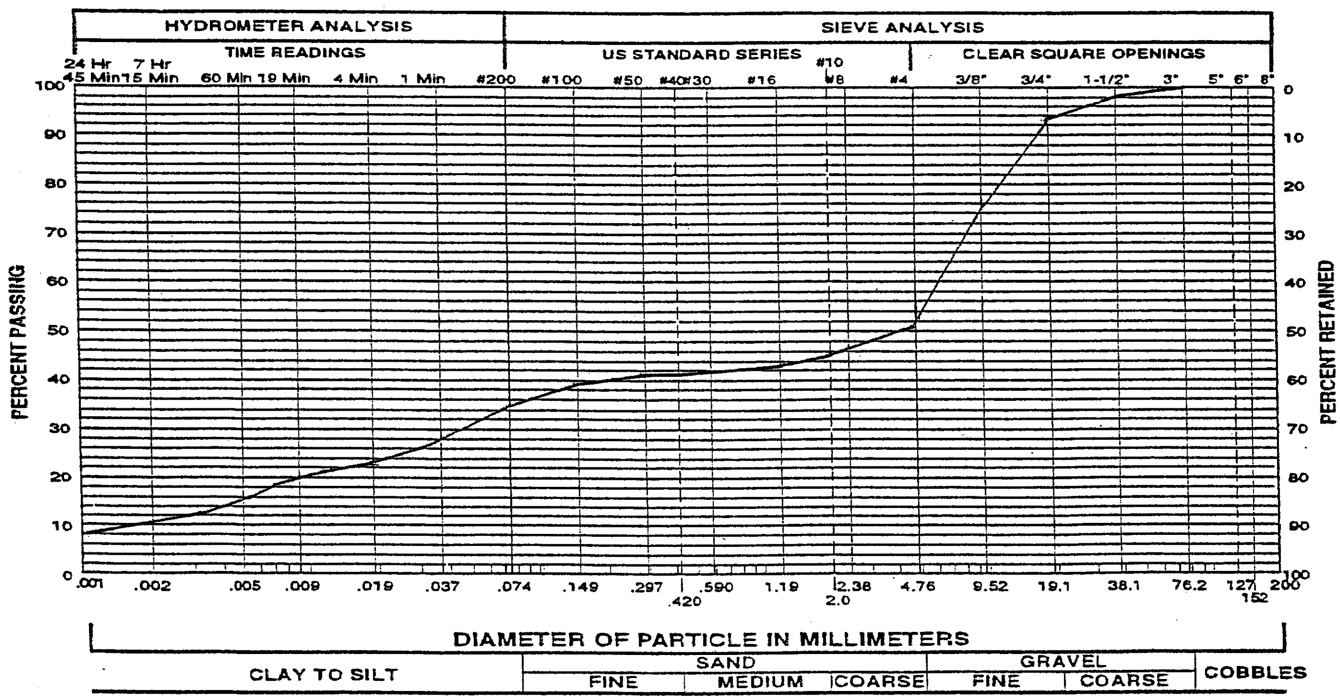
Applied Geotechnical Engineering Consultants, Inc.



Gravel 52 % Sand 30 % Silt and Clay 18 %

Liquid Limit ___ % Plasticity Index ___ %

Sample of Silty Gravel with Sand (GM) From Test Pit DCW-1 @ 0"-38"



Gravel 49 % Sand 16 % Silt and Clay 35 %

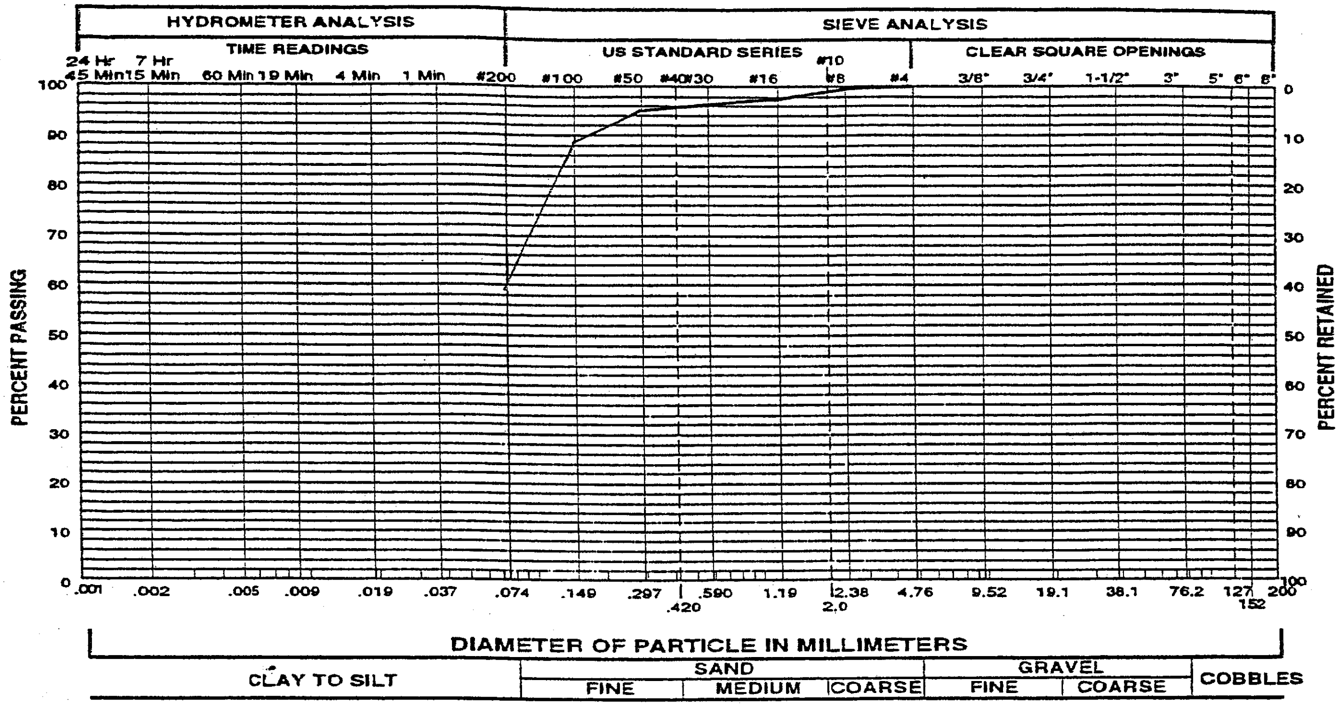
Liquid Limit 33 % Plasticity Index 15 %

Sample of Clayey Gravel with Sand (GC) From Test Pit DCW-3 @ 0"-26"

Project No. 1990648 **GRADATION TEST RESULTS** Figure 1

OCT 11 2006

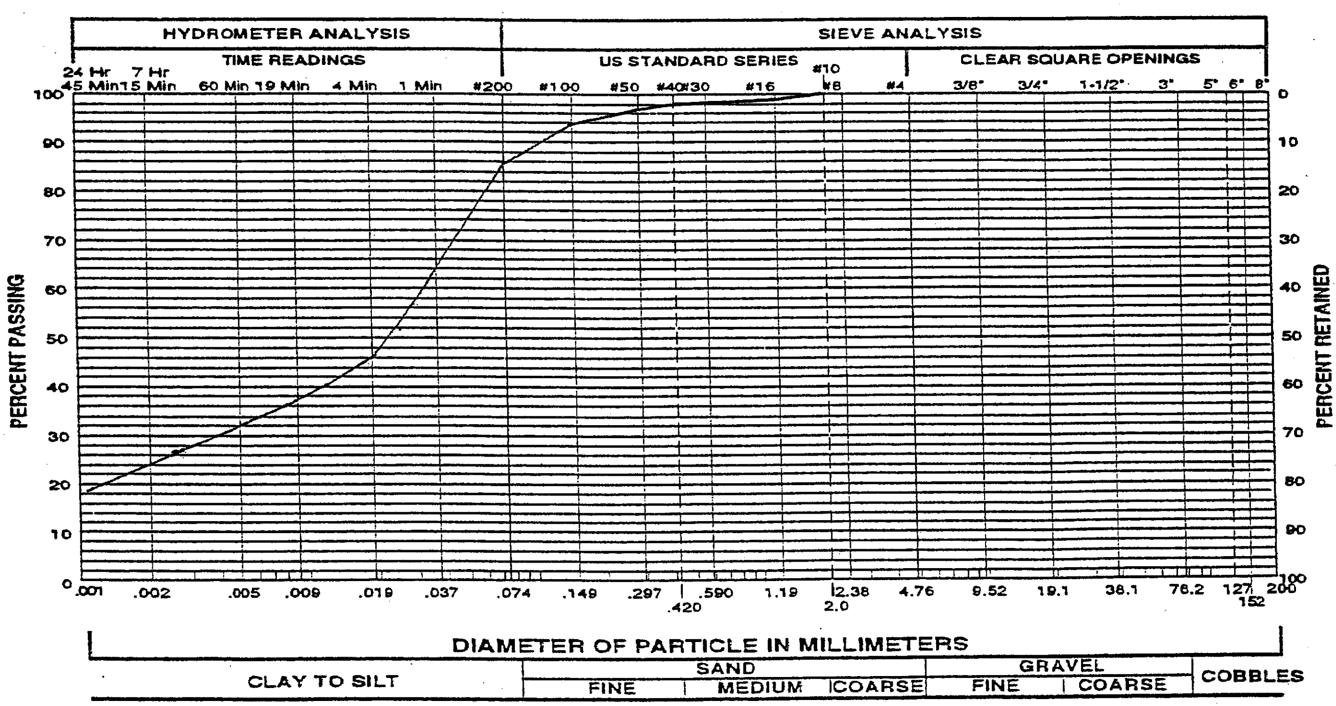
Applied Geotechnical Engineering Consultants, Inc.



Gravel 0 % Sand 41 % Silt and Clay 59 %

Liquid Limit ______ % Plasticity Index ______ %

Sample of Sandy Silt (ML) From Test Pit DCW-6 @ 2.5'-6'



Gravel 0 % Sand 15 % Silt and Clay 85 %

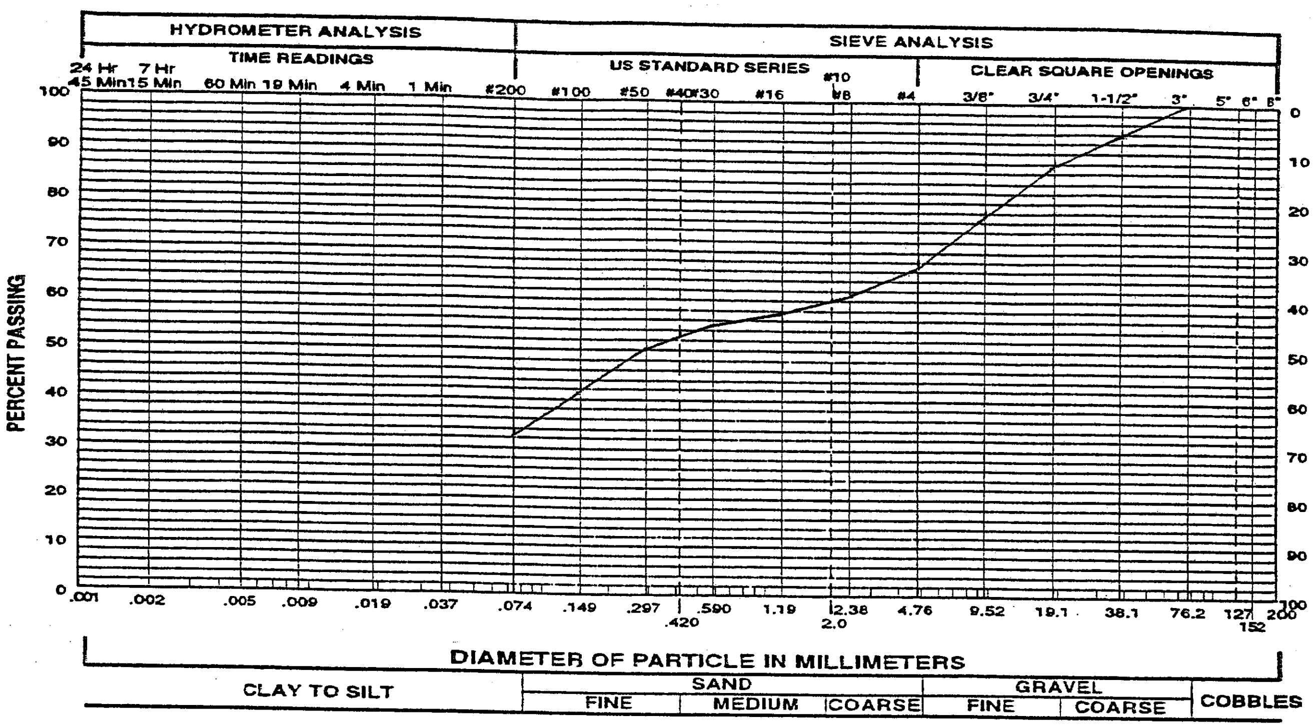
Liquid Limit 26 % Plasticity Index 9 %

Sample of Lean Clay with Sand (CL) From Test Pit DCW-9 @ 0"-14"

Project No. 1990648 **GRADATION TEST RESULTS** Figure 2

OCT 11 2005

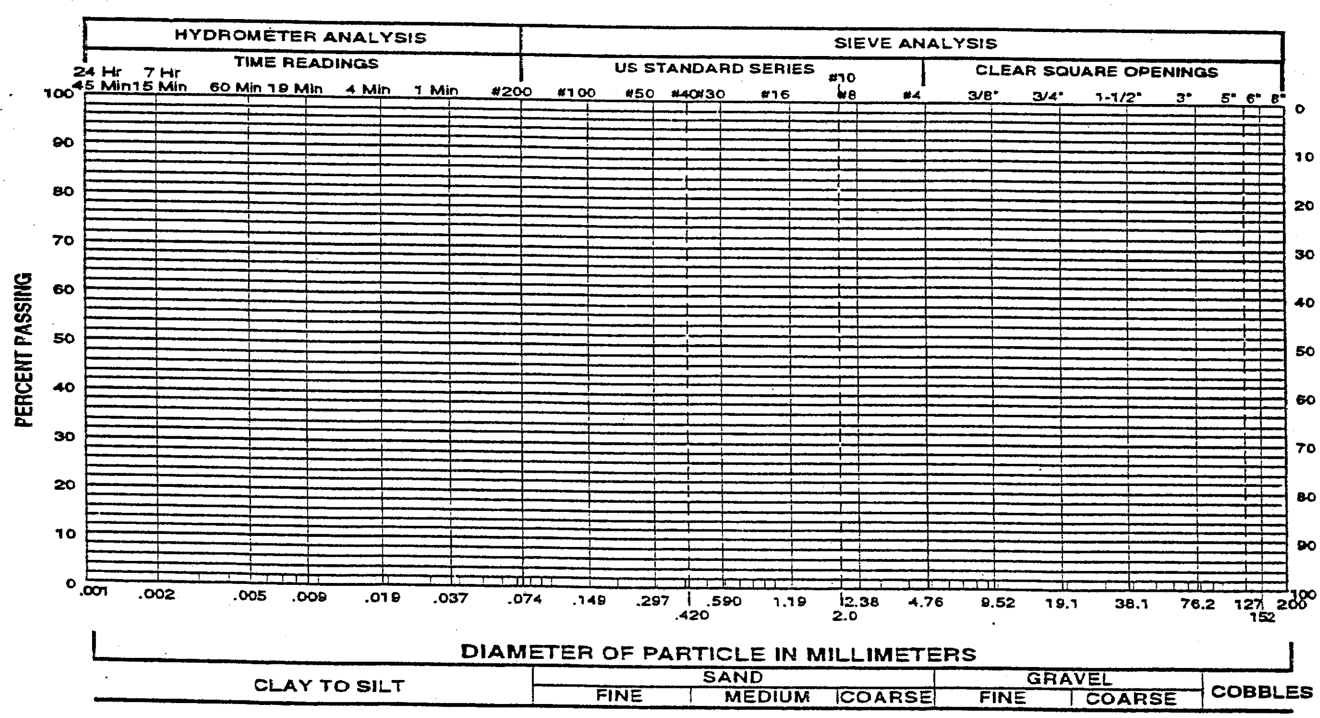
Applied Geotechnical Engineering Consultants, Inc.



Gravel 34 % Sand 34 % Silt and Clay 32 %

Liquid Limit ______ % Plasticity Index ______ %

Sample of Silty Sand with Gravel (SM) From Test Pit DCW-10 @ 13"-102"



Gravel ______ % Sand ______ % Silt and Clay ______ %

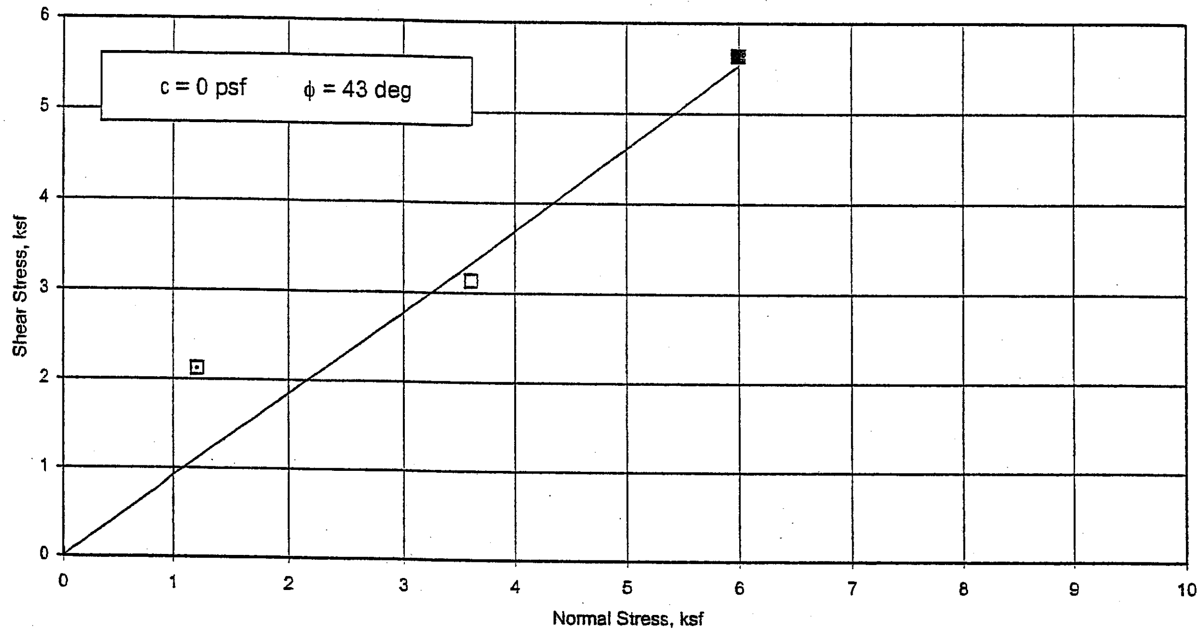
Liquid Limit ______ % Plasticity Index ______ %

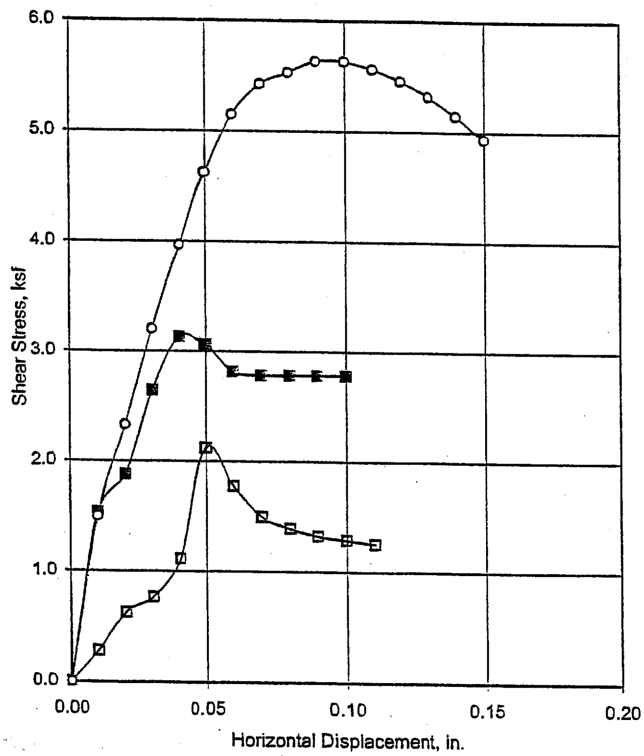
Sample of ______ From ______

Project No. 1990648 **GRADATION TEST RESULTS** Figure 3

OCT 11 2005

Applied Geotechnical Engineering Consultants, Inc.





Test No. (Symbol)	1(□)	2(■)	3(○)
Sample Type	Remolded		
Length, in.	1.00	1.00	1.00
Diameter, in.	1.93	1.93	1.93
Dry Density, pcf	115	115	115
Moisture Content, %	6	6	6
Consolidation Load, ksf	1.2	3.6	6.0
Normal Load, ksf	1.2	3.6	6.0
Shear Stress, ksf	2.12	3.13	5.64
Remarks	Strain Rate 0.05 in/min. Test performed on material passing the No. 4 sieve.		

Sample Index Properties	
Dry Density, pcf	N/A
Moisture Content, %	N/A
Liquid Limit, %	N/A
Plasticity Index, %	N/A
Percent Gravel	52
Percent Sand	30
Percent Passing No. 200 Sieve	18

Type of Test: Consolidated Undrained/Unsaturated

Sample Description: Silty Gravel with Sand (GM) From Test Pit DCW-1 @ 0"-38"

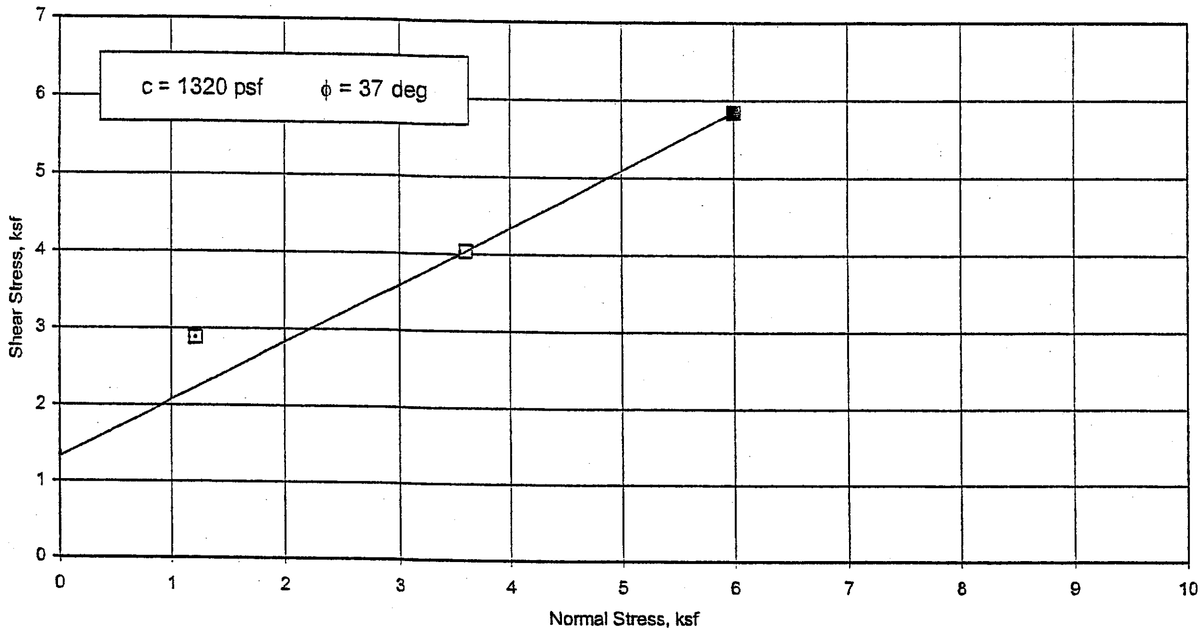
Project No. 1990648

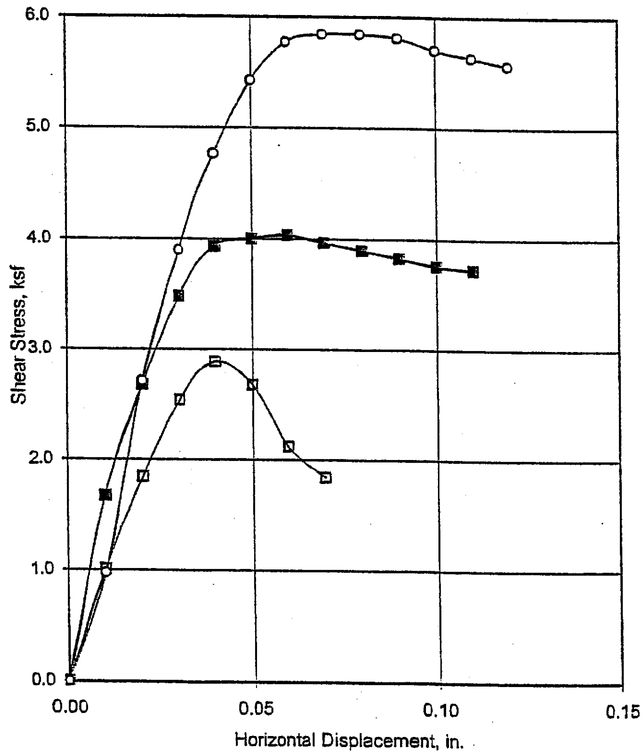
DIRECT SHEAR TEST RESULTS

Figure 4

OCT 11 2006

Applied Geotechnical Engineering Consultants, Inc.





Test No. (Symbol)	1(□)	2(■)	3(O)
Sample Type	Remolded		
Length, in.	1.00	1.00	1.00
Diameter, in.	1.93	1.93	1.93
Dry Density, pcf	113	113	113
Moisture Content, %	6	6	6
Consolidation Load, ksf	1.2	3.6	6.0
Normal Load, ksf	1.2	3.6	6.0
Shear Stress, ksf	2.89	4.04	5.85
Remarks	Strain Rate 0.05 in/min. Test performed on material passing the No. 4 sieve.		

Sample Index Properties	
Dry Density, pcf	N/A
Moisture Content, %	N/A
Liquid Limit, %	33
Plasticity Index, %	15
Percent Gravel	49
Percent Sand	16
Percent Passing No. 200 Sieve	35

Type of Test: Consolidated Undrained/Unsaturated

Sample Description: Clayey Gravel with Sand (GC) From: Test Pit DCW-3 @ 0"-26"

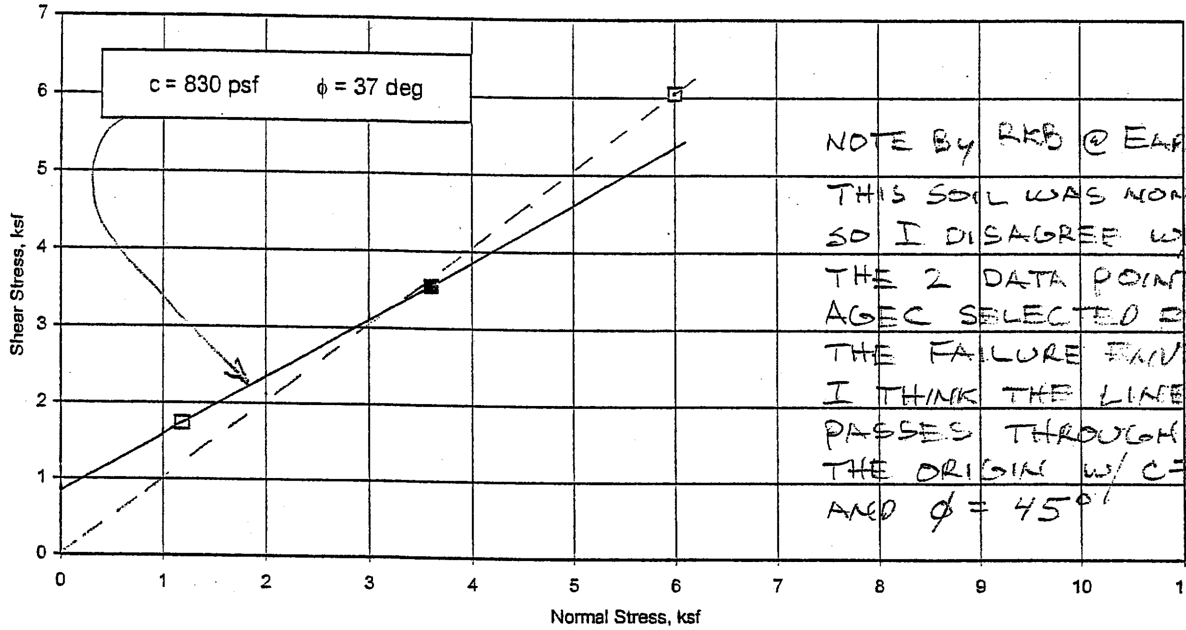
Project No. 1990648

DIRECT SHEAR TEST RESULTS

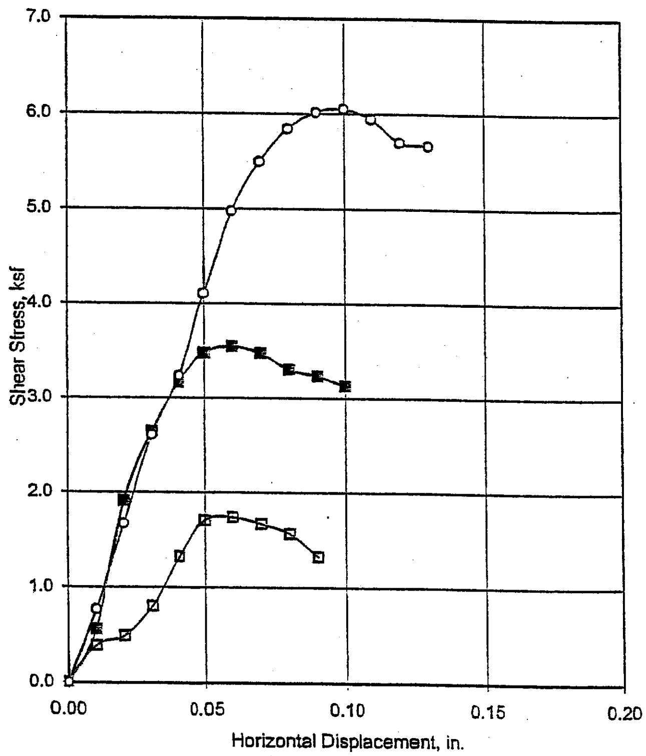
Figure 5

OCT 1 1 2006

Applied Geotechnical Engineering Consultants, Inc.



NOTE BY RKB @ EARTHFAX:
THIS SOIL WAS NONCOHESIVE,
SO I DISAGREE W/
THE 2 DATA POINTS
AGEC SELECTED FOR
THE FAILURE ENVELOPE.
I THINK THE LINE
PASSES THROUGH
THE ORIGIN W/ C=0 PSF
AND ϕ = 45°!



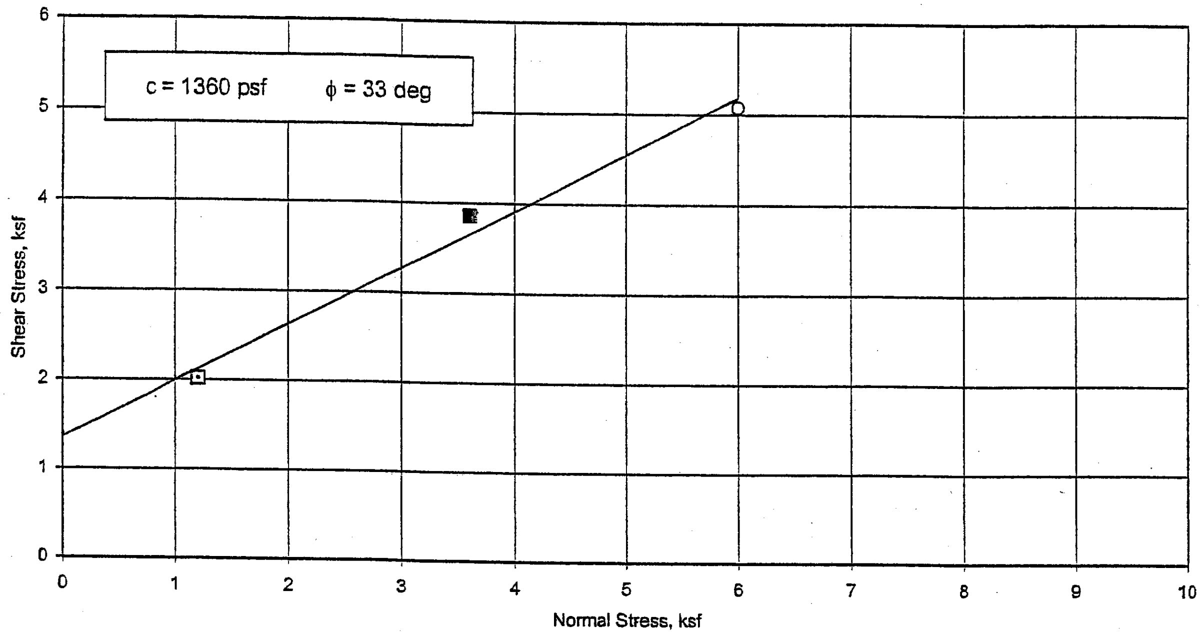
Test No. (Symbol)	1(□)	2(■)	3(○)
Sample Type	Remolded		
Length, in.	1.00	1.00	1.00
Diameter, in.	1.93	1.93	1.93
Dry Density, pcf	112	112	112
Moisture Content, %	9	9	9
Consolidation Load, ksf	1.2	3.6	6.0
Normal Load, ksf	1.2	3.6	6.0
Shear Stress, ksf	1.74	3.55	6.05
Remarks	Strain Rate 0.05 in/min.		
	Test performed on material passing the		
	No. 4 sieve.		

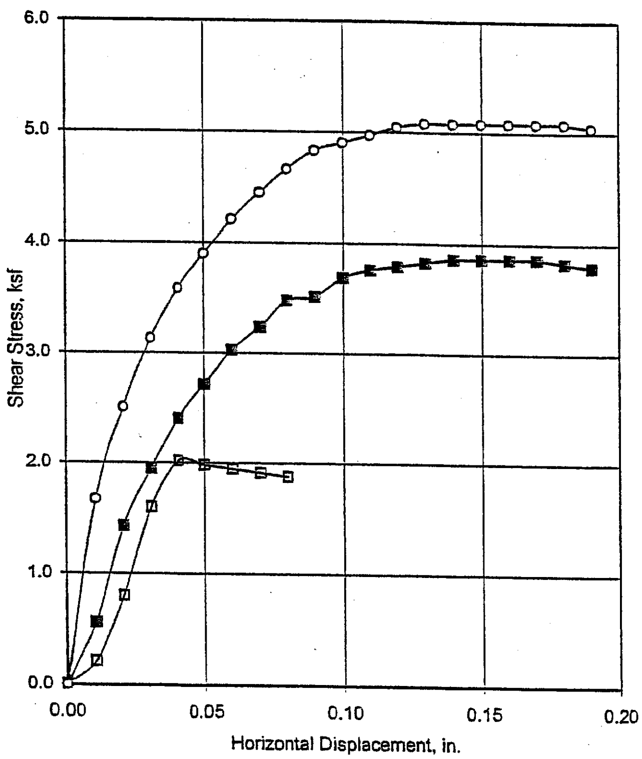
Sample Index Properties	
Dry Density, pcf	N/A
Moisture Content, %	N/A
Liquid Limit, %	N/A
Plasticity Index, %	N/A
Percent Gravel	0
Percent Sand	41
Percent Passing No. 200 Sieve	59

Type of Test: Consolidated Undrained/Unsaturated
Sample Description: Sandy Silt (ML)   From: Test Pit DCW-6 @ 2.5'-6'

Project No. 1990648   **DIRECT SHEAR TEST RESULTS**   Figure 6

Applied Geotechnical Engineering Consultants, Inc.





Test No. (Symbol)	1(□)	2(■)	3(○)
Sample Type		Remolded	
Length, in.	1.00	1.00	1.00
Diameter, in.	1.93	1.93	1.93
Dry Density, pcf	98	98	98
Moisture Content, %	6	6	6
Consolidation Load, ksf	1.2	3.6	6.0
Normal Load, ksf	1.2	3.6	6.0
Shear Stress, ksf	2.02	3.86	5.08
Remarks	Strain Rate 0.05 in/min.		
	Test performed on material passing the		
	No. 4 sieve.		

Sample Index Properties	
Dry Density, pcf	N/A
Moisture Content, %	N/A
Liquid Limit, %	26
Plasticity Index, %	9
Percent Gravel	0
Percent Sand	15
Percent Passing No. 200 Sieve	85

Type of Test: Consolidated Undrained/Unsaturated

Sample Description: Lean Clay with Sand (CL) From Test Pit DCW-9 @ 0"-14"

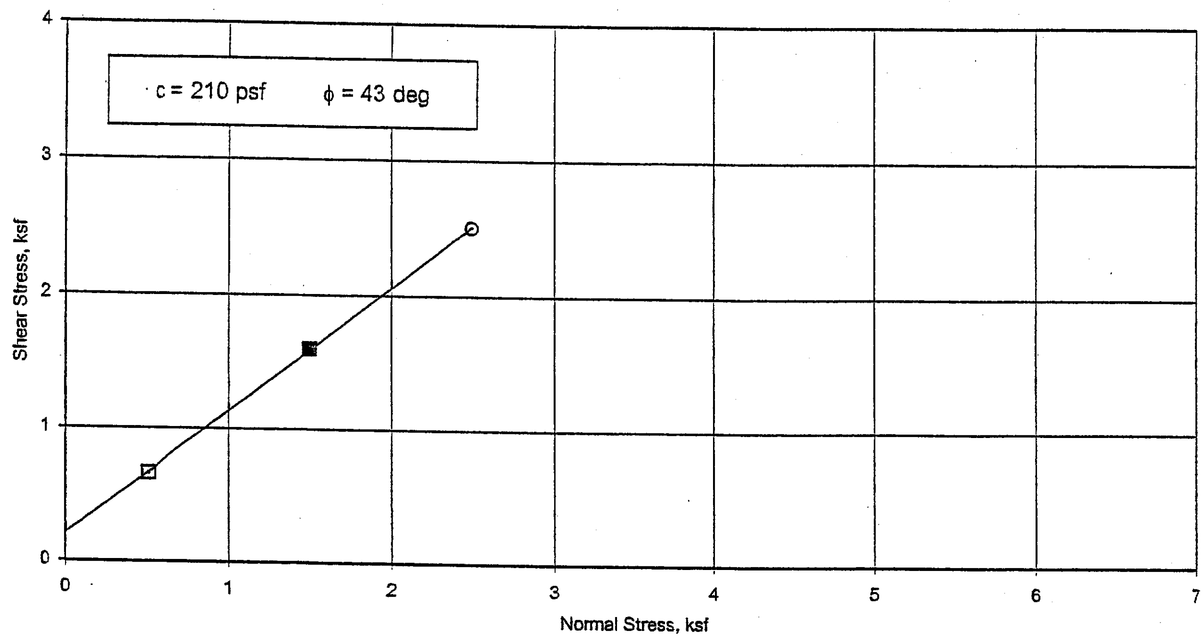
Project No. 1990648

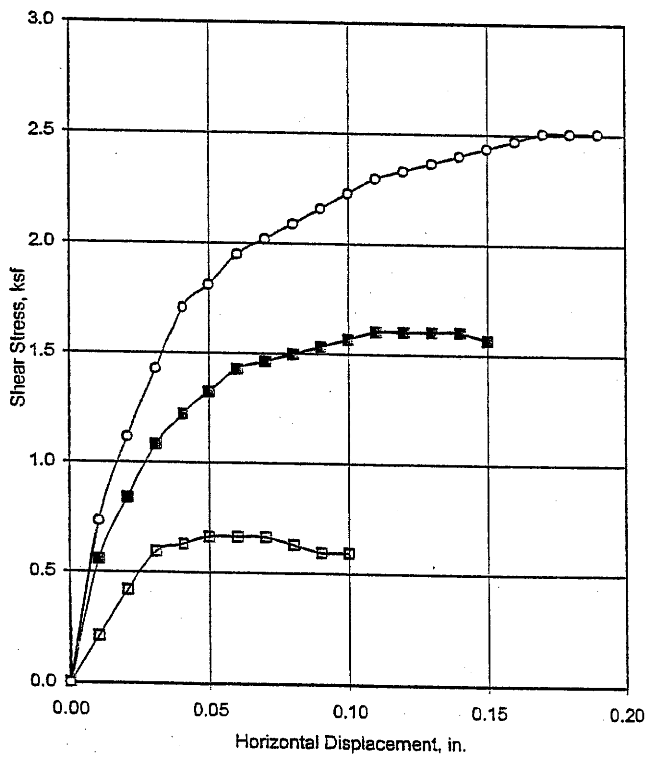
DIRECT SHEAR TEST RESULTS

Figure 7

OCT 1 1 2006

Applied Geotechnical Engineering Consultants, Inc.





Test No. (Symbol)	1(□)	2(■)	3(○)
Sample Type	Remolded		
Length, in.	1.00	1.00	1.00
Diameter, in.	1.93	1.93	1.93
Dry Density, pcf	100	100	100
Moisture Content, %	8	8	8
Consolidation Load, ksf	0.5	1.5	2.5
Normal Load, ksf	0.5	1.5	2.5
Shear Stress, ksf	0.66	1.60	2.51
Remarks	Strain Rate 0.05 in/min. Test performed on material passing the No. 4 sieve.		

Sample Index Properties	
Dry Density, pcf	N/A
Moisture Content, %	N/A
Liquid Limit, %	N/A
Plasticity Index, %	N/A
Percent Gravel	34
Percent Sand	34
Percent Passing No. 200 Sieve	32

Type of Test: Consolidated Undrained/Unsaturated

Sample Description: Silty Sand with Gravel (SM) From: Test Pit DCW-10 @ 13"-102"

Project No. 1990648

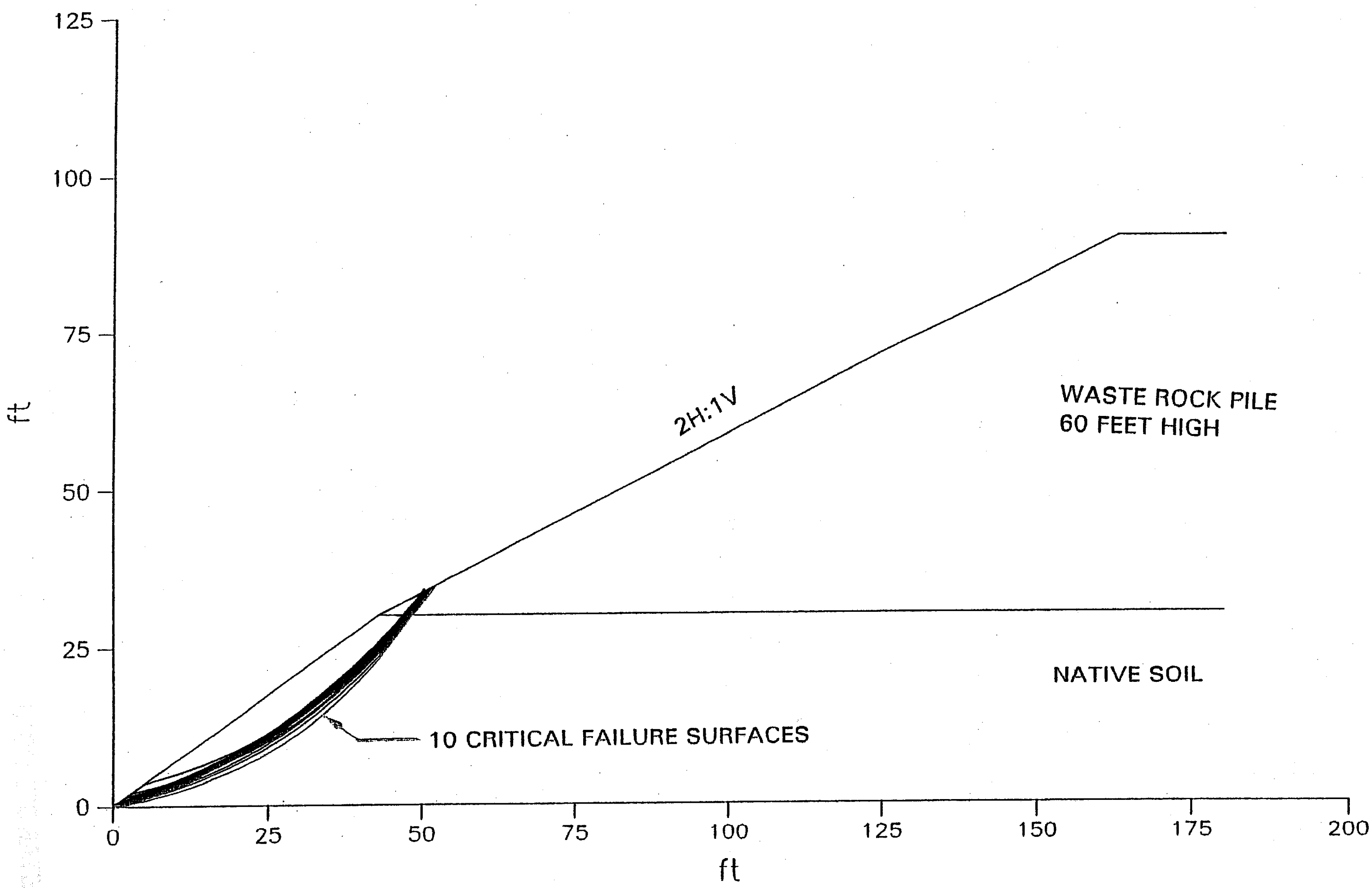
DIRECT SHEAR TEST RESULTS

Figure 8

Bishop Circular Surfaces - Most Critical Surfaces

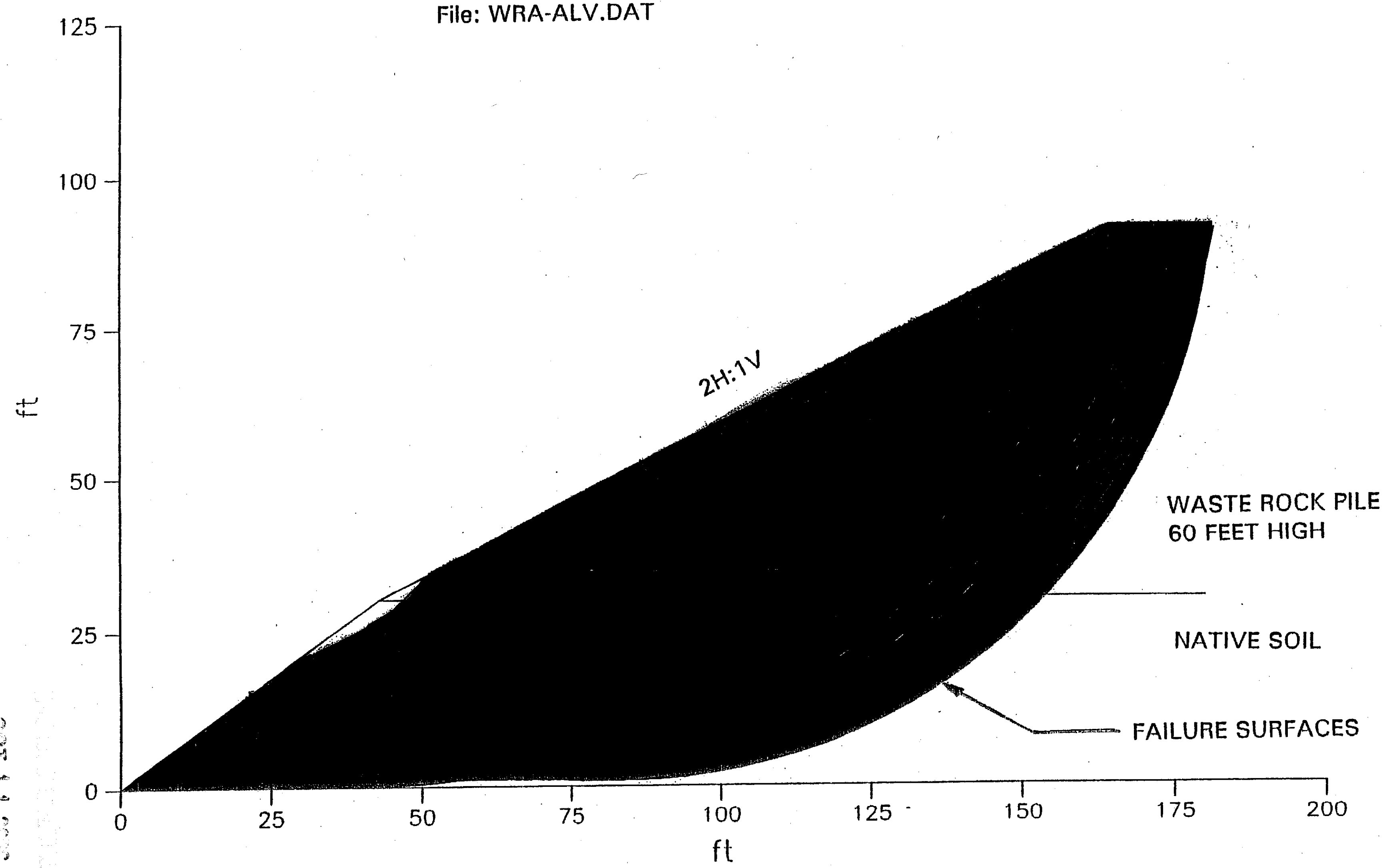
Canyon Fuel Company, LLC
Dugout Canyon Mine
Waste Rock Pile
Section A-A'
6200 Failure Surfaces
File: WRA-ALV.DAT

Minimum Factor of Safety : 1.591



Bishop Circular Surfaces – Search for Critical Surfaces

Canyon Fuel Company, LLC
Dugout Canyon Mine
Waste Rock Pile
Section A-A'
6200 Failure Surfaces
File: WRA-ALV.DAT



```
TITLE
DUGOUT CANYON MINE
PROPOSED WASTE-ROCK PILE
SECTION A-A', ALLUVIAL SOIL, NATIVE SLOPE
PROFIL
4 3
0 0 43 30 2
43 30 163 90 1
163 90 180 90 1
43 30 180 30 2
SOIL
2
122 122 490 35 0 0 0
122 122 0 43 0 0 0
CIRCL2
31 200 0 30 50 180 0 5 25 -35
END
```

```
********************************************************************
*****                        GeoSlope                         *****
*****                      Version 5.00                       *****
*****                                                         *****
*****                                                         *****
*****        (c)1992 by GEOCOMP Corp, Concord, MA             *****
*****          Licensed to EarthFax Engineering               *****
********************************************************************
```

Problem Title: DUGOUT CANYON MINE
Description: PROPOSED WASTE-ROCK PILE
Remarks: SECTION A-A', ALLUVIAL SOIL, NATIVE SLOPE

```
********************************************************************
*****                       INPUT DATA                        *****
********************************************************************
```

Profile Boundaries

Number of Boundaries: 4
Number of Top Boundaries: 3

Boundary No.	X-Left (ft)	Y-Left (ft)	X-Right (ft)	Y-Right (ft)	Soil Type Below Bnd
1	0.00	0.00	43.00	30.00	2
2	43.00	30.00	163.00	90.00	1
3	163.00	90.00	180.00	90.00	1
4	43.00	30.00	180.00	30.00	2

Soil Parameters

Number of Soil Types : 2

Soil Type No.	Total Unit Wt. (pcf)	Saturated Unit Wt. (pcf)	Cohesion Intercept (psf)	Friction Angle (deg)	Pore Pressure Param.	Pressure Constant (psf)	Piez. Surface No.
1	122.0	122.0	490.0	35.0	0.00	0.0	0
2	122.0	122.0	0.0	43.0	0.00	0.0	0

****
*****   TRIAL SURFACE GENERATION   *****
****

Data for Generating Circular Surfaces

Number of Initiation Points:	31
Number of Surfaces From Each Point:	200
Left Initiation Point:	0.00 ft
Right Initiation Point:	30.00 ft
Left Termination Point:	50.00 ft
Right Termination Point:	180.00 ft
Minimum Elevation:	0.00 ft
Segment Length:	5.00 ft
Positive Angle Limit:	25.00 deg
Negative Angle Limit:	-35.00 deg

****
*****   RESULTS   *****
****

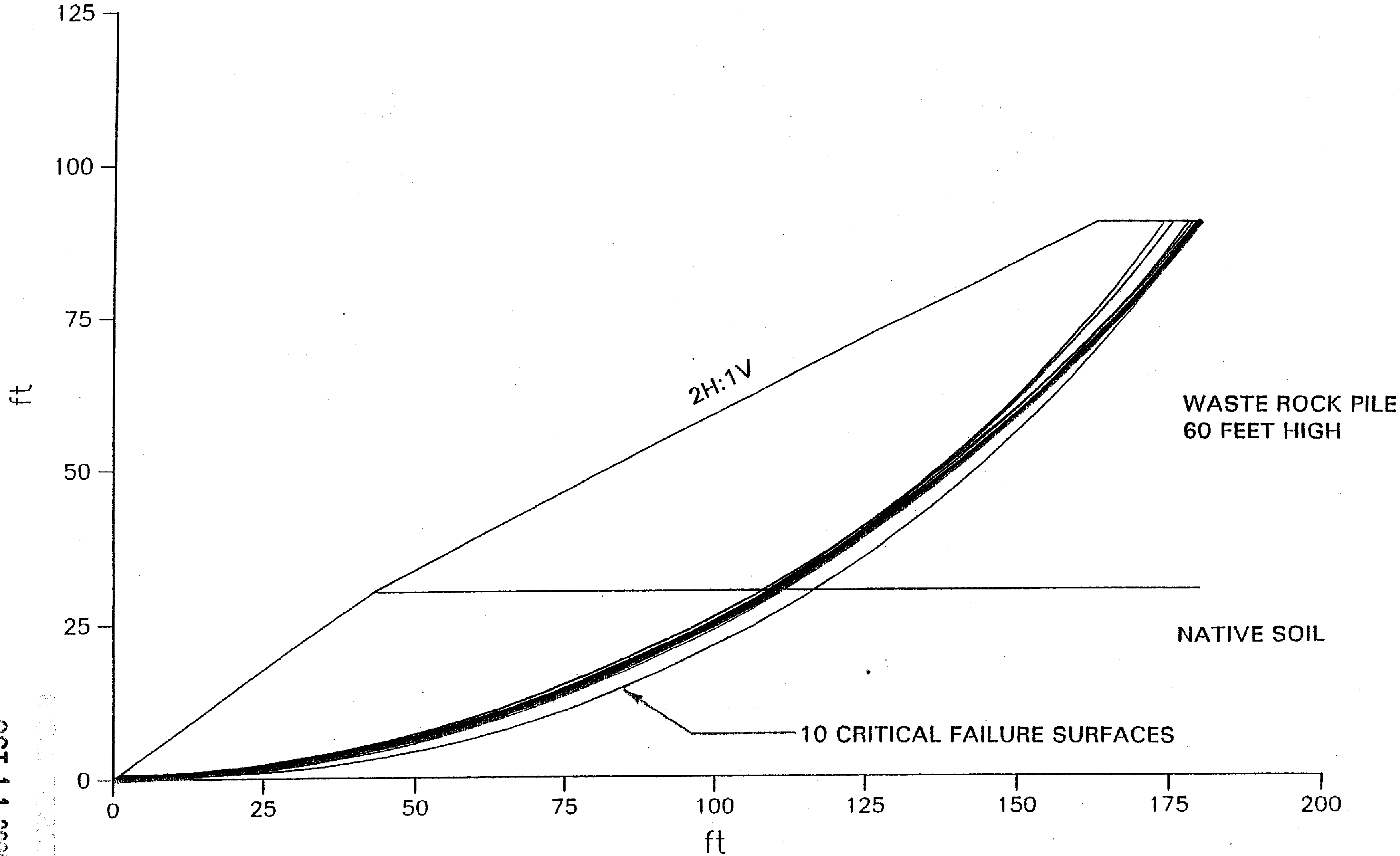
Critical Surfaces

No.	Safety Factor	Center X (ft)	Center Y (ft)	Circle Radius (ft)
1	1.591	-26.84	95.11	98.83
2	1.593	-16.84	79.65	81.41
3	1.612	-18.05	83.16	85.10
4	1.613	-10.85	74.00	73.23
5	1.619	-14.55	77.91	79.26
6	1.622	-12.11	76.75	76.17
7	1.628	-14.19	81.99	80.82
8	1.630	-14.40	82.43	81.29
9	1.633	-8.69	68.06	68.61
10	1.633	-20.87	90.73	92.21

Bishop Circular Surfaces : Most Critical Surfaces

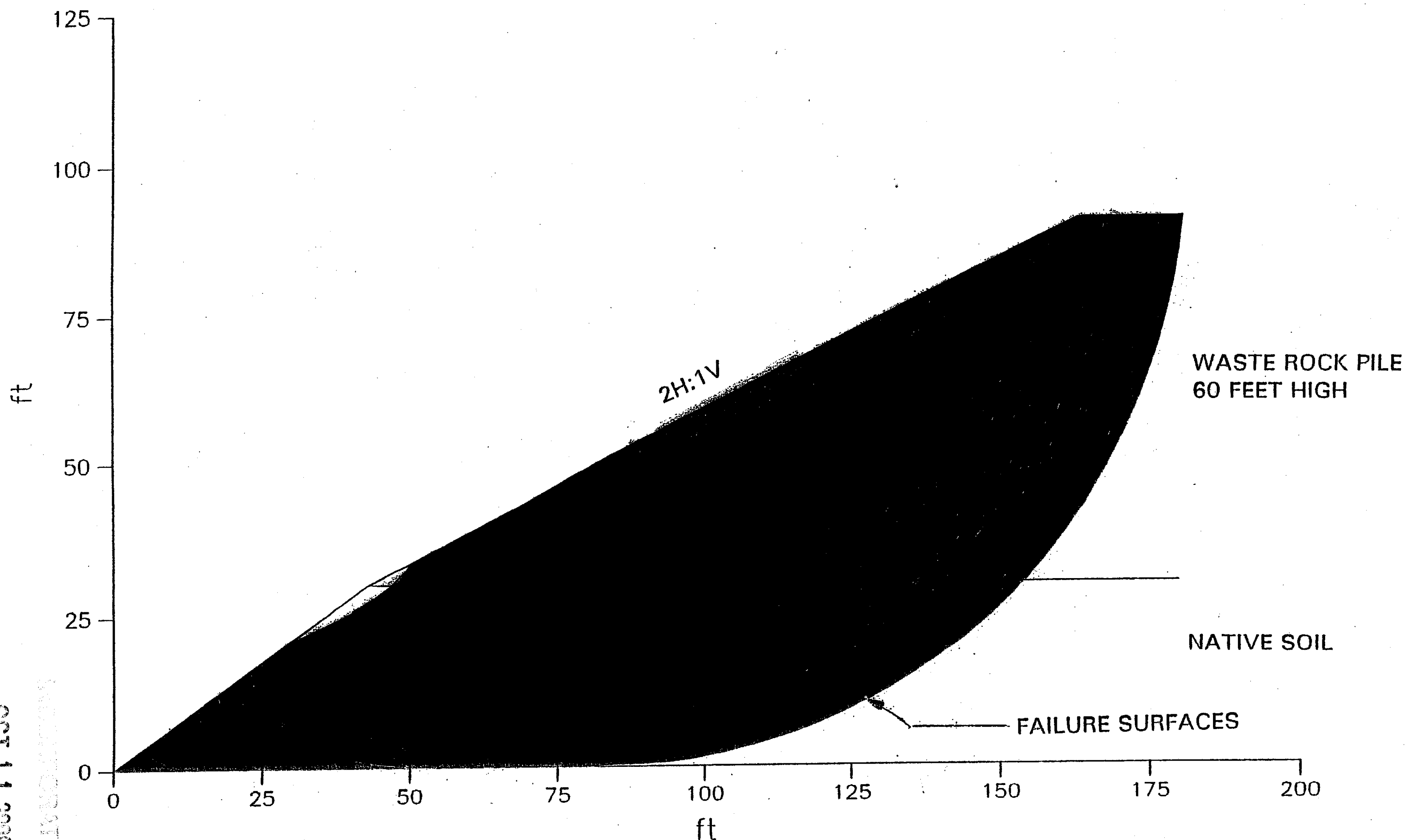
Canyon Fuel Company, LLC
Dugout Canyon Mine
Waste Rock Pile
Section A-A'
6200 Failure Surfaces
File: WRA-MS1.DAT

Minimum Factor of Safety : 2.387



Bishop Circular Surfaces – Search for Critical Surfaces

Canyon Fuel Company, LLC
Dugout Canyon Mine
Waste Rock Pile
Section A-A'
6200 Failure Surfaces
File: WRA-MS1.DAT



```
TITLE
DUGOUT CANYON MINE
PROPOSED WASTE-ROCK PILE
SECTION A-A', MANCOS SOIL, NATIVE SLOPE
PROFIL
4 3
0 0 43 30 2
43 30 163 90 1
163 90 180 90 1
43 30 180 30 2
SOIL
2
122 122 490 35 0 0 0
122 122 1360 33 0 0 0
CIRCL2
31 200 0 30 50 180 0 5 25 -35
END
```

```
*****************************************************************
*****                       GeoSlope                        *****
*****                     Version 5.00                      *****
*****                                                       *****
*****       (c)1992 by GEOCOMP Corp, Concord, MA            *****
*****           Licensed to EarthFax Engineering            *****
*****************************************************************
```

Problem Title : DUGOUT CANYON MINE
Description : PROPOSED WASTE-ROCK PILE
Remarks : SECTION A-A', MANCOS SOIL, NATIVE SLOPE

```
*****************************************************************
*****                      INPUT DATA                       *****
*****************************************************************
```

Profile Boundaries

Number of Boundaries: 4
Number of Top Boundaries: 3

Boundary No.	X-Left (ft)	Y-Left (ft)	X-Right (ft)	Y-Right (ft)	Soil Type Below Bnd
1	0.00	0.00	43.00	30.00	2
2	43.00	30.00	163.00	90.00	1
3	163.00	90.00	180.00	90.00	1
4	43.00	30.00	180.00	30.00	2

Soil Parameters

Number of Soil Types: 2

Soil Type No.	Total Unit Wt. (pcf)	Saturated Unit Wt. (pcf)	Cohesion Intercept (psf)	Friction Angle (deg)	Pore Pressure Param.	Pressure Constant (psf)	Piez. Surface No.
1	122.0	122.0	490.0	35.0	0.00	0.0	0
2	122.0	122.0	1360.0	33.0	0.00	0.0	0

****
*****   TRIAL SURFACE GENERATION   *****
****

Data for Generating Circular Surfaces

Number of Initiation Points:	31
Number of Surfaces From Each Point:	200
Left Initiation Point:	0.00 ft
Right Initiation Point:	30.00 ft
Left Termination Point:	50.00 ft
Right Termination Point:	180.00 ft
Minimum Elevation:	0.00 ft
Segment Length:	5.00 ft
Positive Angle Limit:	25.00 deg
Negative Angle Limit:	-35.00 deg

****
*****   RESULTS   *****
****

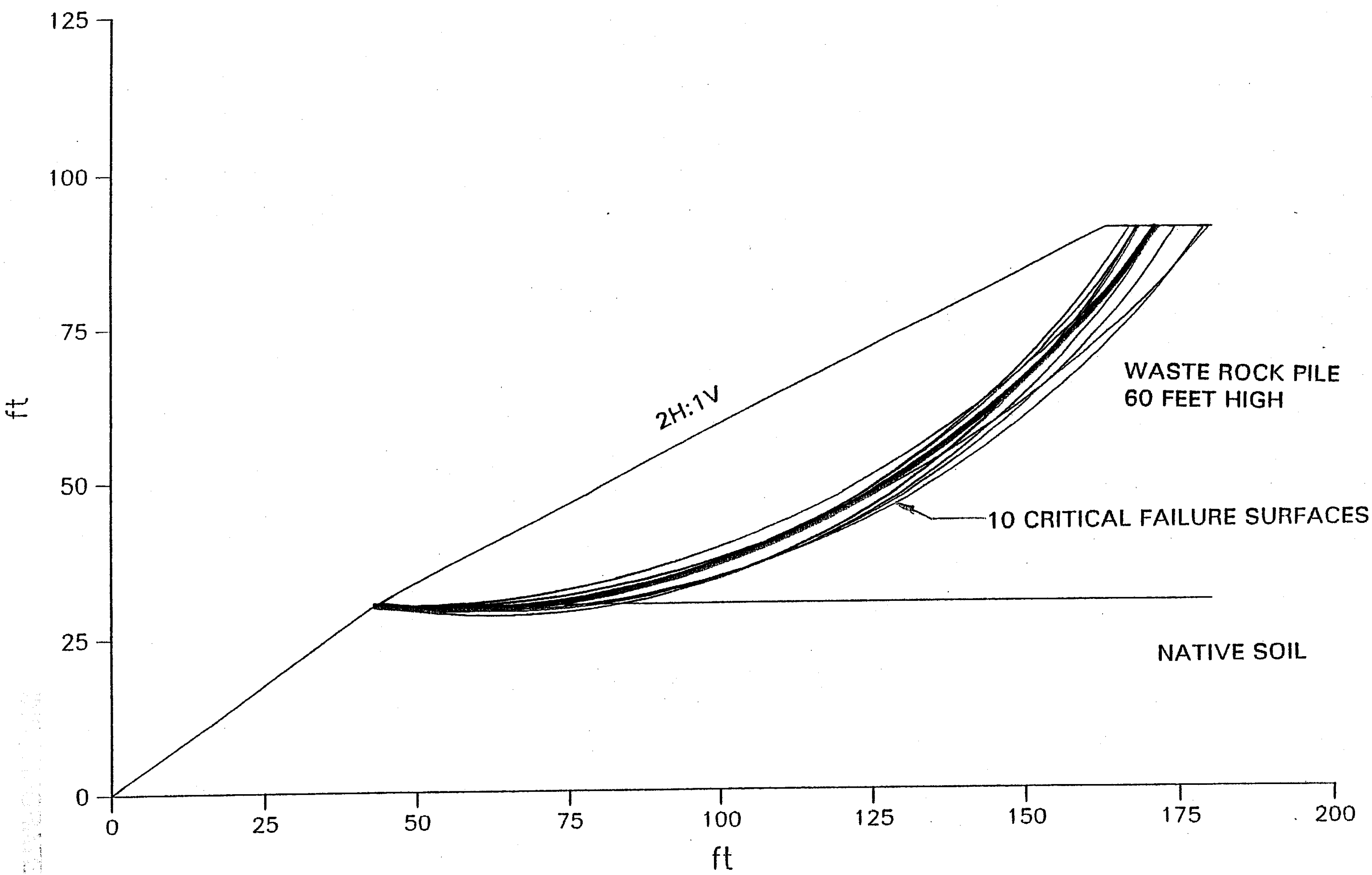
Critical Surfaces

No.	Safety Factor	Center X (ft)	Center Y (ft)	Circle Radius (ft)
1	2.387	-4.27	233.50	233.54
2	2.388	-6.73	238.39	238.49
3	2.389	-5.26	232.61	232.67
4	2.391	-8.87	241.03	241.19
5	2.392	-0.33	216.70	216.70
6	2.393	-0.13	227.00	226.30
7	2.393	-2.03	219.90	219.91
8	2.395	3.18	216.25	215.57
9	2.395	11.14	203.34	202.90
10	2.395	2.04	209.21	209.22

Bishop Circular Surfaces   Most Critical Surfaces

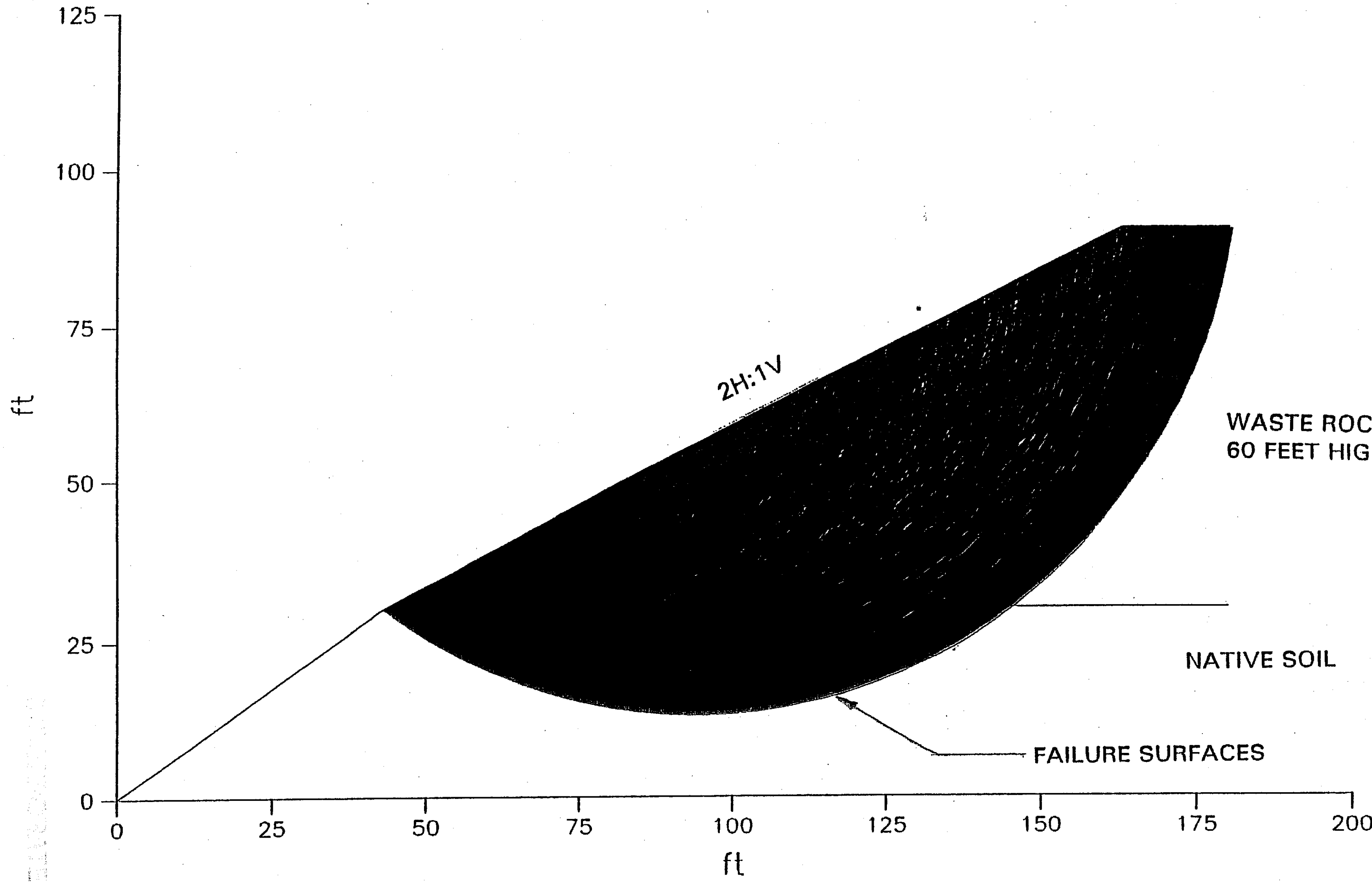
Canyon Fuel Company, LLC
Dugout Canyon Mine
Waste Rock Pile
Section A-A'
6000 Failure Surfaces
File: WRA-WR.DAT

Minimum Factor of Safety : 2.271



Bishop Circular Surfaces — Search for Critical Surfaces

Canyon Fuel Company, LLC
Dugout Canyon Mine
Waste Rock Pile
Section A-A'
6000 Failure Surfaces
File: WRA-WR.DAT



```
TITLE
DUGOUT CANYON MINE
PROPOSED WASTE-ROCK PILE
SECTION A-A', WASTE ROCK SLOPE ONLY
PROFIL
4 3
0 0 43 30 2
43 30 163 90 1
163 90 180 90 1
43 30 180 30 2
SOIL
2
122 122 490 35 0 0 0
122 122 0 43 0 0 0
CIRCL2
6 500 43 48 55 180 0 5 25 -35
END
```

```
*******************************************************************
*****                        GeoSlope                        *****
*****                     Version 5.00                       *****
*****                                                        *****
*****          (c)1992 by GEOCOMP Corp, Concord, MA          *****
*****          Licensed to EarthFax Engineering              *****
*******************************************************************
```

Problem Title: DUGOUT CANYON MINE
Description: PROPOSED WASTE-ROCK PILE
Remarks: SECTION A-A', WASTE ROCK SLOPE ONLY

```
*******************************************************************
*****                       INPUT DATA                       *****
*******************************************************************
```

Profile Boundaries

Number of Boundaries: 4
Number of Top Boundaries: 3

Boundary No.	X-Left (ft)	Y-Left (ft)	X-Right (ft)	Y-Right (ft)	Soil Type Below Bnd
1	0.00	0.00	43.00	30.00	2
2	43.00	30.00	163.00	90.00	1
3	163.00	90.00	180.00	90.00	1
4	43.00	30.00	180.00	30.00	2

Soil Parameters

Number of Soil Types: 2

Soil Type No.	Total Unit Wt. (pcf)	Saturated Unit Wt. (pcf)	Cohesion Intercept (psf)	Friction Angle (deg)	Pore Pressure Param.	Pressure Constant (psf)	Piez. Surface No.
1	122.0	122.0	490.0	35.0	0.00	0.0	0
2	122.0	122.0	0.0	43.0	0.00	0.0	0

****

***** TRIAL SURFACE GENERATION *****

****

Data for Generating Circular Surfaces

Number of Initiation Points:	6
Number of Surfaces From Each Point:	500
Left Initiation Point:	43.00 ft
Right Initiation Point:	48.00 ft
Left Termination Point:	55.00 ft
Right Termination Point:	180.00 ft
Minimum Elevation:	0.00 ft
Segment Length:	5.00 ft
Positive Angle Limit:	25.00 deg
Negative Angle Limit:	-35.00 deg

****

***** RESULTS *****

****

Critical Surfaces

No.	Safety Factor	Center X (ft)	Center Y (ft)	Circle Radius (ft)
1	2.271	56.82	167.20	137.89
2	2.287	57.37	157.99	128.79
3	2.292	63.42	153.66	125.33
4	2.297	51.46	196.36	166.58
5	2.301	63.46	148.34	120.10
6	2.304	63.45	147.51	119.27
7	2.307	63.94	159.04	130.08
8	2.311	63.03	169.80	140.59
9	2.325	47.82	187.82	157.89
10	2.329	57.83	160.97	131.20

Canyon Fuel Company, LLC
Dugout Canyon Mine

Refuse Pile Amendment
February 2005

RA ATTACHMENT 5-3

REFUSE PILE VOLUME CALCULATIONS

REGISTERED PROFESSIONAL ENGINEER
2-11-05
No. 189797
LAYNE D.
JENSEN
★ STATE OF UTAH ★

INCORPORATED
OCT 11 2006
Div. of Oil, Gas & Mining

Determination of Refuse Tonnage for Final Pile Configuration

The existing topography shown on the maps is representative of the site when the last aerial survey was conducted on August 12, 2004. At that time Olympus Aerial Surveys had estimated that 46,217 CY of coal refuse had already been placed at the site.

At the final pile configuration an additional 639,838 CY of coal waste will have been added to the refuse pile.

Total coal refuse in the pile = 46,217 CY + 639,838 CY = 686,055 CY

Unit weight of coal refuse = 110 lbs/ft^3

Tonnage = (686,055 CY * 27 ft^3/CY * 110 lbs/ft^3) / 2000 lbs/ft^3 = 1,018,792 tons

RA ATTACHMENT 5-4

WASTE ROCK ANALYSIS

Inter·Mountain
Laboratories, Inc.

1633 Terra Avenue
Sheridan, Wyoming 82801
Tel. (307) 672-8945
Fax (307) 672-6053

RECEIVED
AUG 28 1995
SOLDIER CREEK COAL CO.

August 24, 1995

Mr. David Spillman
Soldier Creek Coal Company
P.O. Box 1029
Wellington, Utah 84542

Dear Mr. Spillman:

Enclosed are the results for the soil samples our laboratory received August 8, 1995. The analyses were completed according to Utah Dept. of Natural Resources Table 6. (April 1988).

Please note the absence of Coarse Fragment results. Because the samples were waste rock, there was no way to make this determination.

We have centralized our invoicing. All invoices are mailed separately from the report.

Feel free to contact me at your convenience if you have any questions or concerns.

Sincerely,

Joey Sheeley
Joey Sheeley
Mining Soils

xc: File
Encl.

MAR 03 2003

Inter-Mountain Laboratories, Inc.
1633 Terra Avenue
Sheridan, Wyoming 82801
Tel. (307) 672-8945

SOLDIER CREEK COAL COMPANY
WELLINGTON, UTAH

August 24, 1995

Lab No.	Location	Depths feet	pH	EC mmhos/cm @ 25°C	Saturation %	Calcium meq/l	Magnesium meq/l	Sodium meq/l	SAR	Coarse Fragments %	Sand %	Silt %	Clay %	Texture
124887	ROCK CYN ROOF	0.0-0.0	7.8	1.53	24.2	3.49	8.06	4.34	1.81		72.4	20.0	7.6	SANDY LOAM
124888	FLOOR	0.0-0.0	7.7	0.95	35.5	4.46	5.04	0.66	0.30		68.4	22.0	9.6	SANDY LOAM
124889	COAL	0.0-0.0	8.4	0.97	58.4	0.42	0.46	8.02	12.1		88.4	9.0	2.6	SAND
124890	GILSON ROOF	0.0-0.0	7.5	0.66	28.1	2.34	2.79	0.88	0.55		39.4	41.0	19.6	LOAM
124891	FLOOR	0.0-0.0	7.8	1.58	23.4	3.35	8.76	4.57	1.86		69.4	22.0	8.6	SANDY LOAM
124892	COAL	0.0-0.0	7.2	2.30	56.7	23.2	5.68	0.85	0.22		88.4	8.0	3.6	SAND

Miscellaneous Abbreviations: SAR= Sodium Adsorption Ratio, CEC= Cation Exchange Capacity, ESP= Exchangeable Sodium Percentage, Exch= Exchangeable, Avail= Available

Inter-Mountain Laboratories, Inc.
1633 Terra Avenue
Sheridan, Wyoming 82801
Tel. (307) 672-8945

SOLDIER CREEK COAL COMPANY
WELLINGTON, UTAH

August 24, 1995

Lab No.	Location	Depths feet	Total Organic Carbon %	Total Sulfur %	T.S. AB t/1000t	Neut. Pot. t/1000t	T.S. ABP t/1000t	Sulfate Sulfur %	Pyritic Sulfur %	Organic Sulfur %	PyrS AB t/1000t	PyrS ABP t/1000t
124887	ROCK CYN ROOF	0.0-0.0	3.6	0.17	5.31	181.	176.					
124888	FLOOR	0.0-0.0	1.8	0.02	0.62	88.2	87.5					
124889	COAL	0.0-0.0	93.3	0.38	11.9	43.6	31.7					
124890	GILSON ROOF	0.0-0.0	4.9	0.02	0.62	1.74	1.12					
124891	FLOOR	0.0-0.0	4.5	0.09	2.81	173.	171.					
124892	COAL	0.0-0.0	93.3	0.45	14.1	23.8	9.69					

Abbreviations used in acid base accounting: T.S.= Total Sulfur, AB= Acid Base, ABP= Acid Base Potential, PyrS= Pyritic Sulfur, Pyr+Org= Pyritic Sulfur + Organic Sulfur, Neut. Pot.= Neutralization Potential

Inter-Mountain Laboratories, Inc.

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SOLDIER CREEK COAL COMPANY
WELLINGTON, UTAH

August 24, 1995

Lab No.	Location	Depths feet	Nitrate-Nitrogen ppm	Boron ppm	Selenium ppm	Avail Na meq/100g	Exch Na meq/100g	CEC meq/100g	Total Kjeldahl Nitrogen %	1/3 bar	15 bar
124887	ROCK CYN ROOF	0.0-0.0	1.02	0.28	0.02	0.37	0.26	2.24	0.03	9.6	2.4
124888	FLOOR	0.0-0.0	1.26	0.29	<0.02	0.28	0.26	3.42	0.02	10.3	3.0
124889	COAL	0.0-0.0	1.22	1.64	<0.02	0.69	0.22	1.30	0.77	9.5	8.1
124890	GILSON ROOF	0.0-0.0	1.20	0.97	0.08	0.28	0.26	8.62	0.04	14.9	4.1
124891	FLOOR	0.0-0.0	1.26	0.28	0.02	0.38	0.27	2.40	0.03	13.7	2.9
124892	COAL	0.0-0.0	1.20	1.77	<0.02	0.39	0.34	1.38	0.74	17.8	7.9

Miscellaneous Abbreviations: SAR= Sodium Adsorption Ratio, CEC= Cation Exchange Capacity, ESP= Exchangeable Sodium Percentage, Exch= Exchangeable, Avail= Available

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Inter·Mountain Laboratories, Inc.

1633 Terra Avenue | Sheridan, Wyoming 82801 | Tel. (307) 672-8945

SOLDIER CREEK COAL COMPANY
WELLINGTON, UTAH

August 24, 1995

Lab No.	Location	Depths feet	pH	EC mmhos/cm @ 25°C	Saturation %	Calcium meq/l	Magnesium meq/l	Sodium meq/l	SAR	Coarse Fragments %	Sand %	Silt %	Clay %	Texture
124888	FLOOR	0.0-0.0	7.7	0.95	35.5	4.46	5.04	0.66	0.30		68.4	22.0	9.6	SANDY LOAM
124894	124888(DUP)	0.0-0.0	7.8	0.94	35.6	4.18	4.53	0.80	0.38		67.4	23.0	9.6	SANDY LOAM

Miscellaneous Abbreviations: SAR= Sodium Adsorption Ratio, CEC= Cation Exchange Capacity, ESP= Exchangeable Sodium Percentage, Exch= Exchangeable, Avail= Available

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SOLDIER CREEK COAL COMPANY
WELLINGTON, UTAH

August 24, 1995

Lab No.	Location	Depths feet	Total Organic Carbon %	Total Sulfur %	T.S. AB t/1000t	Neut. Pot. t/1000t	T.S. ABP t/1000t	Sulfate Sulfur %	Pyritic Sulfur %	Organic Sulfur %	PyrS AB t/1000t	PyrS ABP t/1000t
124888	FLOOR	0.0-0.0	1.8	0.02	0.62	88.2	87.5					
124894	124888(DUP)	0.0-0.0	1.6	0.02	0.62	92.0	91.4					

Abbreviations used in acid base accounting: T.S.= Total Sulfur, AB= Acid Base, ABP= Acid Base Potential, PyrS= Pyritic Sulfur, Pyr+Org= Pyritic Sulfur + Organic Sulfur, Neut. Pot.= Neutralization Potential

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SOLDIER CREEK COAL COMPANY
WELLINGTON, UTAH

August 24, 1995

Lab No.	Location	Depths feet	Nitrate-Nitrogen ppm	Boron ppm	Selenium ppm	Avail Na meq/100g	Exch Na meq/100g	CEC meq/100g	Total Kjeldahl Nitrogen %	1/3 bar	15 bar
124888	FLOOR	0.0-0.0	1.26	0.29	<0.02	0.28	0.26	3.42	0.02	10.3	3.0
124894	124888(DUP)	0.0-0.0	1.04	0.28	<0.02	0.28	0.25	3.54	0.02	14.6	2.8

Miscellaneous Abbreviations: SAR= Sodium Adsorption Ratio, CEC= Cation Exchange Capacity, ESP= Exchangeable Sodium Percentage, Exch= Exchangeable, Avail= Available

APPENDIX 5-7

Waste-Rock Analyses

MAR 0 3 2000

LICENSED PROFESSIONAL ENGINEER
No. 168246
RICHARD B. WHITE
10/23/98
STATE OF UTAH

INCORPORATED
EFFECTIVE:
OCT 19 1998
98-1
UTAH DIVISION OIL, GAS AND MINING

Inter-Mountain Laboratories, Inc.
1633 Terra Avenue
Sheridan, Wyoming 82801
Tel. (307) 672-8945

CANYON FUEL COMPANY
HELPER, UTAH
MINE: SKYLINE

July 1, 1998

Lab No.	Location	Depths	pH	EC mmhos/cm @ 25°C	Saturation %	Calcium meq/l	Magnesium meq/l	Sodium meq/l	SAR	Sand %	Silt %	Clay %	Texture
155184	WASTE ROCK 1		7.2	4.36		17.8	41.9	0.98	0.18	49.0	25.0	26.0	SANDY CLAY LOAN

INCORPORATED
EFFECTIVE:
OCT 19 1998
98-1
UTAH DIVISION OIL, GAS AND MINING

MAR 03 2003

Miscellaneous Abbreviations: SAR= Sodium Adsorption Ratio, CEC= Cation Exchange Capacity, ESP= Exchangeable Sodium Percentage, Exch= Exchangeable, Avail= Available

Inter-Mountain Laboratories, Inc.
1633 Terra Avenue Sheridan, Wyoming 82801 Tel. (307) 672-8945

CANYON FUEL COMPANY
HELPER, UTAH
MINE: SKYLINE

July 1, 1998

Lab No.	Location	Depths	Total Sulfur %	T.S. AB t/1000t	Neut. Pot. t/1000t	T.S. ABP t/1000t	Sulfate Sulfur %	Pyritic Sulfur %	Organic Sulfur %	PyrS AB t/1000t	PyrS ABP t/1000t
155184	WASTE ROCK 1		2.42	75.6	81.2	5.55					

Abbreviations used in acid base accounting: T.S.= Total Sulfur, AB= Acid Base, ABP= Acid Base Potential, PyrS= Pyritic Sulfur, Pyr+Org= Pyritic Sulfur + Organic Sulfur, Neut. Pot.= Neutralization Potential

Inter·Mountain Laboratories, Inc.

1633 Terra Avenue Sheridan, Wyoming 82801 Tel. (307) 672-8945

CANYON FUEL COMPANY
HELPER, UTAH
MINE: SKYLINE

July 1, 1998

Lab No.	Location	Depths	Nitrate-Nitrogen ppm	Boron ppm	Avail Na meq/100g	Exch Na meq/100g	Total Kjeldahl Nitrogen %	AB-DTPA Selenium ppm	1/3 bar	15 bar
155184	WASTE ROCK 1		0.36	0.5				0.06		

Abbreviations for extractants: PE= Saturated Paste Extract, H2OSol= water soluble, AB-DTPA= Ammonium Bicarbonate-DTPA, AAO= Acid Ammonium Oxalate
Miscellaneous Abbreviations: SAR= Sodium Adsorption Ratio, CEC= Cation Exchange Capacity, ESP= Exchangeable Sodium Percentage, Exch= Exchangeable, Avail= Available

Inter-Mount Laboratories, Inc.

1633 Terra Avenue
Sheridan, WY 82801

Canyon Fuel Co

Dugout Mine

Client Project ID: Gilson Well

Date Received: 10/16/02

Set #0102S21101

Report Date: 11/06/02

Lab Id	Sample Id	TOC	Total Sulfur	T.S. AB	Neutral. Pot.	T.S. ABP	Boron	Nitrogen - Nitrate	Selenium	Available Sodium	Exchangeable Sodium	TKN
		%	%	t/1000t	t/1000t	t/1000t	ppm	ppm	ppm	meq/100g	meq/100g	%
0102S21101	Gilson Well	1.5	0.38	11.9	119	107	0.27	1.14	0.02	2.24	1.75	0.07

MAR 03 2003

Abbreviations for extractants: PE= Saturated Paste Extract, H20Sol= water soluble,AB-DTPA= Ammonium Bicarbonate-DTPA, AAO= Acid Ammonium Oxalate

Abbreviations used in acid base accounting: T.S.= Total Sulfur, AB= Acid Base, ABP= Acid Base Potential, PyrS= Pyritic Sulfur, Pyr+Org= Pyritic Sulfur + Organic Sulfur, Neut. Pot.= Neutralization Potential

Miscellaneous Abbreviations: SAR= Sodium Adsorption Ratio, CEC= Cation Exchange Capacity, ESP= Exchangeable Sodium Percentage

Reviewed By:

Joey Sheeley
Soils Lab Supervisor

Inter-Moun Laboratories, Inc.

1633 Terra Avenue
Sheridan, WY 82801

Canyon Fuel Co

Dugout Mine

Client Project ID: Gilson Well

Date Received: 10/16/02

Set #0102S21101

Report Date: 11/06/02

Lab Id	Sample Id	Coarse Fragments	Sand	Silt	Clay	Texture	Field Capacity	Wilting Point
		%	%	%	%		%	%
0102S21101	Gilson Well	45.2	75.0	11.0	14.0	SANDY LOAM	9.0	4.2

MAR 03 2003

Abbreviations for extractants: PE= Saturated Paste Extract, H20Sol= water soluble,AB-DTPA= Ammonium Bicarbonate-DTPA, AAO= Acid Ammonium Oxalate

Abbreviations used in acid base accounting: T.S.= Total Sulfur, AB= Acid Base, ABP= Acid Base Potential, PyrS= Pyritic Sulfur, Pyr+Org= Pyritic Sulfur + Organic Sulfur, Neut. Pot.= Neutralization Potential

Miscellaneous Abbreviations: SAR= Sodium Adsorption Ratio, CEC= Cation Exchange Capacity, ESP= Exchangeable Sodium Percentage

Reviewed By:

Joey Sheeley
Soils Lab Supervisor

Inter·Moun[illegible] Laboratories, Inc.

1633 Terra Avenue
Sheridan, WY 82801

Canyon Fuel Co

Dugout Mine

Client Project ID: Gilson Well

Date Received: 10/16/02

Set #0102S21101

Report Date: 11/06/02

Lab Id	Sample Id	pH	Saturation	EC @ 25°C	Calcium	Magnesium	Sodium	SAR
		s.u.	%	mmhos/cm	meq/L	meq/L	meq/L	
0102S21101	Gilson Well	8.0	24.5	3.18	6.51	3.19	19.9	9.05

Abbreviations for extractants: PE= Saturated Paste Extract, H20Sol= water soluble,AB-DTPA= Ammonium Bicarbonate-DTPA, AAO= Acid Ammonium Oxalate

Abbreviations used in acid base accounting: T.S.= Total Sulfur, AB= Acid Base, ABP= Acid Base Potential, PyrS= Pyritic Sulfur, Pyr+Org= Pyritic Sulfur + Organic Sulfur, Neut. Pot.= Neutralization Potential

Miscellaneous Abbreviations: SAR= Sodium Adsorption Ratio, CEC= Cation Exchange Capacity, ESP= Exchangeable Sodium Percentage

Reviewed By:

Joey Sheeley
Soils Lab Supervisor

Inter-Mountain Laboratories Inc.
1633 Terra Avenue Sheridan, WY 82801
Phone (307) 672-8945 Fax (307) 672-6053

November 6, 2002

Ms. Vicki S. Miller
Canyon Fuel Company
Dugout Mine
HC 35 Box 380
Helper, Utah 84526

Dear Ms. Miller:

Enclosed are the results of the soil analysis for samples our laboratory received on October 16. The analyses were completed according to methods described in USDA Handbook 60 and the American Society of Agronomy monographs.

Feel free to contact me at your convenience if you have any questions or concerns.

Sincerely,

Joey Sheeley
Mining Soils

xc: File
Encl.

Inter-Mountain Laboratories, Inc.

erra Avenue
Sheridan, WY 82801

Canyon Fuel Company, LLC

Canyon Fuel

Client Project ID: Skyline Mine

Set #0101S18408

Date Received: 09/20/01

Report Date: 10/03/01

Lab Id	Sample Id	pH	Saturation	EC @ 25°C	Calcium	Magnesium	Sodium	SAR	Available Sodium	Exchangeable Sodium
		s.u.	%	mmhos/cm	meq/L	meq/L	meq/L		meq/100g	meq/100g
0101S18408	Soil Sample	7.4	36.1	6.84	28.0	22.1	29.0	5.80	1.79	0.74

Composite Sediment
Sample from Dugout
CANYON MINE Sediment
Pond After transport
to Banning.

INCORPORATED
NOV 28 2001
DIV OF OIL GAS & MINING

MAR 03 2003

Abbreviations for extractants: PE= Saturated Paste Extract, H20Sol= water soluble,AB-DTPA= Ammonium Bicarbonate-DTPA, AAO= Acid Ammonium Oxalate

Abbreviations used in acid base accounting: T.S.= Total Sulfur, AB= Acid Base, ABP= Acid Base Potential, PyrS= Pyritic Sulfur, Pyr+Org= Pyritic Sulfur + Organic Sulfur, Neut. Pot.= Neutralization Potential

Miscellaneous Abbreviations: SAR= Sodium Adsorption Ratio, CEC= Cation Exchange Capacity, ESP= Exchangeable Sodium Percentage

Reviewed By:

Joey Sheeley
Soils Lab Supervisor

Inter-Mount Laboratories, Inc.
Terra Avenue
Sheridan, WY 82801

Canyon Fuel Company, LLC

Canyon Fuel

Client Project ID: Skyline Mine

Date Received: 09/20/01

Set #0101S18408

Report Date: 10/03/01

Lab Id	Sample Id	1/3 Bar %	15 Bar %	Coarse Fragments %	Sand %	Silt %	Clay %	Texture
0101S18408	Soil Sample	20.4	12.0	6.1	42.0	34.0	24.0	LOAM

Abbreviations for extractants: PE= Saturated Paste Extract, H20Sol= water soluble,AB-DTPA= Ammonium Bicarbonate-DTPA, AAO= Acid Ammonium Oxalate

Abbreviations used in acid base accounting: T.S.= Total Sulfur, AB= Acid Base, ABP= Acid Base Potential, PyrS= Pyritic Sulfur, Pyr+Org= Pyritic Sulfur + Organic Sulfur, Neut. Pot.= Neutralization Potential

Miscellaneous Abbreviations: SAR= Sodium Adsorption Ratio, CEC= Cation Exchange Capacity, ESP= Exchangeable Sodium Percentage

Reviewed By: ______________________

Joey Sheeley
Soils Lab Supervisor

Inter-Mountain Laboratories, Inc.

...erra Avenue
Sheridan, WY 82801

Canyon Fuel Company, LLC

Canyon Fuel

Client Project ID: Skyline Mine

Date Received: 09/20/01

Set #0101S18408

Report Date: 10/03/01

Lab Id	Sample Id	TOC	Total Sulfur	T.S. AB	Neutral. Pot.	T.S. ABP	Boron	Nitrogen Nitrate	Selenium	TKN
		%	%	t/1000t	t/1000t	t/1000t	ppm	ppm	ppm	%
0101S18408	Soil Sample	7.4	0.03	0.94	145	145	0.91	2.16	0.02	0.20

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NOV 2 8 2001
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MAR 0 3 2003

Abbreviations for extractants: PE= Saturated Paste Extract, H20Sol= water soluble,AB-DTPA= Ammonium Bicarbonate-DTPA, AAO= Acid Ammonium Oxalate

Abbreviations used in acid base accounting: T.S.= Total Sulfur, AB= Acid Base, ABP= Acid Base Potential, PyrS= Pyritic Sulfur, Pyr+Org= Pyritic Sulfur + Organic Sulfur, Neut. Pot.= Neutralization Potential

Miscellaneous Abbreviations: SAR= Sodium Adsorption Ratio, CEC= Cation Exchange Capacity, ESP= Exchangeable Sodium Percentage

Reviewed By: ______________________

Joey Sheeley
Soils Lab Supervisor

RA ATTACHMENT 5-4

WASTE ROCK ANALYSIS

Inter·Mountain Laboratories, Inc.

1673 Terra Avenue
Sheridan, WY 82801

Report ID: 010501744

Soil Analysis Report

Canyon Fuel Co
Dugout Mine
P.O. Box 1029
Wellington, UT 84542

Client Project ID: Dugout Canyon Mine
Date Received: 03/23/05

Set #0105S01744
Report Date: 04/08/05

Lab Id	Sample Id	pH	Saturation	EC @ 25°C	Calcium	Magnesium	Sodium	SAR	Sand	Silt	Clay	Texture
		s.u.	%	dS/m	meq/L	meq/L	meq/L		%	%	%	
105S01744	12-3-04A	6.6	46.0	1.59	8.44	7.19	1.25	0.45	88.0	8.0	4.0	SAND
105S01745	12-3-04B	6.9	46.1	1.68	8.49	7.01	1.15	0.41	84.0	12.0	4.0	LOAMY SAND
105S01746	12-6-04A	7.0	41.4	1.80	9.31	7.77	1.25	0.43	86.0	10.0	4.0	LOAMY SAND
105S01747	12-6-04B	6.7	40.0	1.98	10.7	8.98	1.45	0.46	84.0	10.0	6.0	LOAMY SAND
105S01748	12-07-04A	6.8	42.9	2.04	11.2	9.19	1.16	0.36	87.0	9.0	4.0	LOAMY SAND
105S01749	12-07-04B	6.9	43.1	1.86	9.94	8.10	1.07	0.35	88.0	8.0	4.0	SAND
105S01750	12-9-04A	6.8	37.3	2.50	14.8	11.3	1.27	0.35	84.0	10.0	6.0	LOAMY SAND
105S01751	12-9-04B	6.9	38.5	2.36	14.5	11.0	1.20	0.33	84.0	12.0	4.0	LOAMY SAND
105S01752	12-16-04A	7.3	37.8	2.64	16.4	12.9	1.37	0.36	86.0	10.0	4.0	LOAMY SAND
105S01753	12-16-04B	7.1	40.2	2.19	12.5	10.5	1.16	0.34	86.0	9.0	5.0	LOAMY SAND
105S01754	12-29-04	7.1	39.7	1.56	6.96	7.39	1.31	0.49	86.0	10.0	4.0	LOAMY SAND
105S01755	12-20-04A	7.2	37.3	2.01	11.5	9.52	1.11	0.34	84.0	12.0	4.0	LOAMY SAND
105S01756	12-20-04B	7.1	37.6	2.35	14.3	11.3	1.26	0.35	86.0	10.0	4.0	LOAMY SAND
105S01757	12-21-04A	6.9	40.6	1.89	10.0	8.89	1.14	0.37	87.0	9.0	4.0	LOAMY SAND
105S01758	12-21-04B	7.2	37.6	1.87	10.1	8.93	1.12	0.36	84.0	12.0	4.0	LOAMY SAND

These results only apply to the samples tested.

Abbreviations for extractants: PE= Saturated Paste Extract, H20Sol= water soluble,AB-DTPA= Ammonium Bicarbonate-DTPA, AAO= Acid Ammonium Oxalate
Abbreviations used in acid base accounting: T.S.= Total Sulfur, AB= Acid Base, ABP= Acid Base Potential, PyrS= Pyritic Sulfur, Pyr+Org= Pyritic Sulfur + Organic Sulfur, Neut. Pot.= Neutralization Potential
Miscellaneous Abbreviations: SAR= Sodium Adsorption Ratio, CEC= Cation Exchange Capacity, ESP= Exchangeable Sodium Percentage

Reviewed By: ____________________
Joey Sheeley, Soils Lab Supervisor

Inter-Mountain Laboratories, Inc.

1673 Terra Avenue
Sheridan, WY 82801

Report ID: 010501744

Soil Analysis Report

Canyon Fuel Co
Dugout Mine
P.O. Box 1029
Wellington, UT 84542

Client Project ID: Dugout Canyon Mine
Date Received: 03/23/05

Set #0105S01744
Report Date: 04/08/05

Lab Id	Sample Id	Coarse Fragments %	Field Capacity %	Wilt Point %	Available Sodium meq/100g	Exchangeable Sodium meq/100g	Boron ppm	Nitrogen Nitrate ppm	Selenium ppm	TKN %
105S01744	12-3-04A	24.3	17.5	4.9	0.07	0.01	0.48	0.20	0.04	0.79
105S01745	12-3-04B	22.9	17.6	4.7	0.07	0.02	0.40	0.14	0.04	0.56
105S01746	12-6-04A	19.5	20.3	5.2	0.07	0.02	0.50	0.12	0.04	0.96
105S01747	12-6-04B	20.2	22.1	5.1	0.08	0.02	0.38	0.10	0.04	0.53
105S01748	12-07-04A	27.6	16.1	4.3	0.06	0.01	0.54	0.12	0.08	0.83
105S01749	12-07-04B	32.6	16.6	4.6	0.07	0.02	0.44	0.10	0.06	0.55
105S01750	12-9-04A	36.9	21.9	4.9	0.08	0.03	0.48	0.10	0.08	0.42
105S01751	12-9-04B	30.2	17.6	5.1	0.07	0.02	0.46	0.10	0.08	0.79
105S01752	12-16-04A	35.3	17.7	4.8	0.07	0.02	0.40	0.08	0.06	0.31
105S01753	12-16-04B	35.2	18.6	5.2	0.07	0.02	0.36	0.12	0.06	1.16
105S01754	12-29-04	14.7	22.1	4.6	0.08	0.03	0.42	0.08	0.02	0.39
105S01755	12-20-04A	30.6	19.2	4.7	0.07	0.03	0.26	0.06	0.04	0.67
105S01756	12-20-04B	32.4	17.8	4.7	0.07	0.02	0.36	0.08	0.04	0.59
105S01757	12-21-04A	33.1	20.0	4.7	0.08	0.03	0.36	0.10	0.04	0.40
105S01758	12-21-04B	31.1	18.5	4.7	0.07	0.03	0.42	0.08	0.04	0.86

These results only apply to the samples tested.

Abbreviations for extractants: PE= Saturated Paste Extract, H20Sol= water soluble,AB-DTPA= Ammonium Bicarbonate-DTPA, AAO= Acid Ammonium Oxalate
Abbreviations used in acid base accounting: T.S.= Total Sulfur, AB= Acid Base, ABP= Acid Base Potential, PyrS= Pyritic Sulfur, Pyr+Org= Pyritic Sulfur + Organic Sulfur, Neut. Pot.= Neutralization Potential
Miscellaneous Abbreviations: SAR= Sodium Adsorption Ratio, CEC= Cation Exchange Capacity, ESP= Exchangeable Sodium Percentage

Reviewed By: ____________________

Joey Sheeley, Soils Lab Supervisor

OCT 1 7 2005

Inter·Mountain Laboratories, Inc.

1673 Terra Avenue
Sheridan, WY 82801

Report ID: 010501744

Soil Analysis Report

Canyon Fuel Co

Dugout Mine
P.O. Box 1029
Wellington, UT 84542

Client Project ID: Dugout Canyon Mine
Date Received: 03/23/05

Set #0105S01744
Report Date: 04/08/05

Lab Id	Sample Id	TOC %	Total Sulfur %	T.S. AB t/1000t	Neutral. Pot. t/1000t	T.S. ABP t/1000t
105S01744	12-3-04A	71.5	0.61	19.1	18.0	-1.06
105S01745	12-3-04B	70.1	0.64	20.0	18.2	-1.81
105S01746	12-6-04A	64.1	0.69	21.6	19.9	-1.67
105S01747	12-6-04B	62.7	0.69	21.6	20.5	-1.02
105S01748	12-07-04A	65.6	0.70	21.9	20.0	-1.83
105S01749	12-07-04B	64.2	0.71	22.2	21.6	-0.60
105S01750	12-9-04A	57.6	0.64	20.0	17.3	-2.71
105S01751	12-9-04B	56.0	0.65	20.3	18.6	-1.74
105S01752	12-16-04A	60.7	0.55	17.2	21.2	4.04
105S01753	12-16-04B	54.0	0.56	17.5	21.6	4.06
105S01754	12-29-04	51.5	0.52	16.2	31.2	15.0
105S01755	12-20-04A	51.9	0.56	17.5	21.2	3.66
105S01756	12-20-04B	51.8	0.56	17.5	20.3	2.78
105S01757	12-21-04A	52.7	0.55	17.2	32.3	15.1
105S01758	12-21-04B	52.2	0.50	15.6	31.4	15.8

These results only apply to the samples tested.

Abbreviations for extractants: PE= Saturated Paste Extract, H20Sol= water soluble,AB-DTPA= Ammonium Bicarbonate-DTPA, AAO= Acid Ammonium Oxalate
Abbreviations used in acid base accounting: T.S.= Total Sulfur, AB= Acid Base, ABP= Acid Base Potential, PyrS= Pyritic Sulfur, Pyr+Org= Pyritic Sulfur + Organic Sulfur, Neut. Pot.= Neutralization Potential
Miscellaneous Abbreviations: SAR= Sodium Adsorption Ratio, CEC= Cation Exchange Capacity, ESP= Exchangeable Sodium Percentage

Reviewed By:

Joey Sheeley, Soils Lab Supervisor

OCT 1 1 2005

Inter-Mountain Laboratories, Inc.

Report ID: 010501744

1673 Terra Avenue
Sheridan, WY 82801

Soil Analysis Report

Canyon Fuel Co
Dugout Mine
P.O. Box 1029
Wellington, UT 84542

Client Project ID: Dugout Canyon Mine
Date Received: 03/23/05

Set #0105S01744
Report Date: 04/08/05

Lab Id	Sample Id	pH	Saturation	EC @ 25°C	Calcium	Magnesium	Sodium	SAR	Sand	Silt	Clay	Texture
		s.u.	%	dS/m	meq/L	meq/L	meq/L		%	%	%	
05S01759	12-22-04A	7.2	38.2	1.89	10.1	9.36	1.31	0.42	84.0	12.0	4.0	LOAMY SAND
05S01760	12-22-04B	7.3	39.5	1.88	9.21	9.00	1.27	0.42	84.0	12.0	4.0	LOAMY SAND
105S01761	1-4-05A	7.3	40.8	1.40	6.79	6.24	1.29	0.51	86.3	8.7	5.0	LOAMY SAND
105S01762	1-7-05A	7.6	40.1	2.54	17.0	11.2	1.38	0.37	90.0	6.0	4.0	SAND
105S01763	1-13-05A	7.5	36.4	2.40	14.5	11.7	1.76	0.49	87.0	9.0	4.0	LOAMY SAND
105S01764	1-14-05A	7.3	39.0	2.89	21.0	13.2	1.52	0.37	88.0	8.0	4.0	SAND
105S01765	1-15-05A	7.2	39.9	2.85	20.7	13.0	1.35	0.33	86.0	10.0	4.0	LOAMY SAND
105S01766	2-9-05A	7.5	43.1	1.26	4.60	5.58	1.67	0.74	84.0	12.0	4.0	LOAMY SAND
105S01767	2-10-05A	7.5	43.9	1.15	4.13	4.86	1.57	0.74	88.0	8.0	4.0	SAND
105S01768	2-11-05A	7.6	42.5	1.13	3.88	4.72	1.76	0.85	91.0	7.0	2.0	SAND
105S01769	2-28-05A	7.5	40.4	1.40	5.66	5.85	1.64	0.68	89.0	7.0	4.0	SAND
105S01770	3-1-05A	7.5	39.1	1.18	4.13	4.79	1.63	0.77	85.0	9.0	6.0	LOAMY SAND
105S01771	3-2-05A	7.4	36.9	1.69	5.58	7.10	1.82	0.72	83.0	11.0	6.0	LOAMY SAND
105S01772	3-3-05A	7.4	38.5	1.41	5.69	6.07	1.67	0.69	83.0	11.0	6.0	LOAMY SAND
105S01773	3-8-05A	7.7	40.0	1.09	3.15	4.13	2.11	1.11	85.0	9.0	6.0	LOAMY SAND

hese results only apply to the samples tested.

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Reviewed By:

Joey Sheeley, Soils Lab Supervisor

OCT 2005

Inter-Mountain Laboratories, Inc.

Report ID: 010501744

1673 Terra Avenue
Sheridan, WY 82801

Soil Analysis Report

Canyon Fuel Co

Dugout Mine
P.O. Box 1029
Wellington, UT 84542

Client Project ID: Dugout Canyon Mine
Date Received: 03/23/05

Set #0105S01744
Report Date: 04/08/05

Lab Id	Sample Id	Coarse Fragments %	Field Capacity %	Wilt Point %	Available Sodium meq/100g	Exchangeable Sodium meq/100g	Boron ppm	Nitrogen Nitrate ppm	Selenium ppm	TKN %
105S01759	12-22-04A	10.4	19.0	4.6	0.07	0.02	0.48	0.16	0.04	0.40
105S01760	12-22-04B	11.4	18.1	4.8	0.07	0.02	0.48	0.22	0.04	0.83
105S01761	1-4-05A	4.6	20.1	5.3	0.11	0.06	0.52	0.12	0.02	0.48
105S01762	1-7-05A	48.7	21.6	4.6	0.08	0.02	0.50	0.20	0.02	0.96
105S01763	1-13-05A	6.1	22.8	5.1	0.08	0.02	0.50	0.16	0.04	0.28
105S01764	1-14-05A	59.7	20.5	5.1	0.08	0.02	0.34	0.16	0.02	0.73
105S01765	1-15-05A	60.9	19.2	5.5	0.07	0.02	0.40	0.14	0.02	0.74
105S01766	2-9-05A	1.9	14.9	6.6	0.10	0.03	0.46	0.16	0.02	0.59
105S01767	2-10-05A	2.8	23.8	6.3	0.09	0.02	0.38	0.16	0.02	0.64
105S01768	2-11-05A	2.5	21.8	6.7	0.10	0.03	0.34	0.14	0.02	0.85
105S01769	2-28-05A	3.8	21.6	6.9	0.10	0.03	0.44	0.24	0.02	0.54
105S01770	3-1-05A	3.5	22.1	6.6	0.10	0.04	0.42	0.14	0.02	0.56
105S01771	3-2-05A	3.1	21.8	6.9	0.10	0.03	0.48	0.16	0.02	0.89
105S01772	3-3-05A	3.7	22.2	7.1	0.10	0.04	0.50	0.16	0.02	0.33
105S01773	3-8-05A	3.7	19.8	7.4	0.12	0.04	0.66	0.20	0.02	0.42

hese results only apply to the samples tested.

bbreviations for extractants: PE= Saturated Paste Extract, H20Sol= water soluble,AB-DTPA= Ammonium Bicarbonate-DTPA, AAO= Acid Ammonium Oxalate
bbreviations used in acid base accounting: T.S.= Total Sulfur, AB= Acid Base, ABP= Acid Base Potential, PyrS= Pyritic Sulfur, Pyr+Org= Pyritic Sulfur + Organic Sulfur, Neut. Pot.= Neutralization Potential
liscellaneous Abbreviations: SAR= Sodium Adsorption Ratio, CEC= Cation Exchange Capacity, ESP= Exchangeable Sodium Percentage

leviewed By:

Joey Sheeley, Soils Lab Supervisor

Inter-Mountain Laboratories, Inc.

1673 Terra Avenue
Sheridan, WY 82801

Report ID: 010501744

Soil Analysis Report

Canyon Fuel Co

Dugout Mine
P.O. Box 1029
Wellington, UT 84542

Client Project ID: Dugout Canyon Mine
Date Received: 03/23/05

Set #0105S01744
Report Date: 04/08/05

Lab Id	Sample Id	TOC	Total Sulfur	T.S. AB	Neutral. Pot.	T.S. ABP
		%	%	t/1000t	t/1000t	t/1000t
105S01759	12-22-04A	53.5	0.53	16.6	26.9	10.4
105S01760	12-22-04B	52.7	0.55	17.2	26.7	9.52
105S01761	1-4-05A	61.9	0.49	15.3	20.7	5.42
105S01762	1-7-05A	60.7	0.54	16.9	25.2	8.31
105S01763	1-13-05A	49.3	0.48	15.0	38.1	23.1
105S01764	1-14-05A	57.5	0.53	16.6	28.5	11.9
105S01765	1-15-05A	57.7	0.55	17.2	27.1	9.90
105S01766	2-9-05A	67.1	0.54	16.9	18.0	1.10
105S01767	2-10-05A	72.9	0.51	15.9	18.1	2.16
105S01768	2-11-05A	71.5	0.52	16.2	14.3	-1.93
105S01769	2-28-05A	63.7	0.51	15.9	21.9	6.00
105S01770	3-1-05A	58.7	0.53	16.6	22.4	5.80
105S01771	3-2-05A	53.7	0.50	15.6	22.8	7.15
105S01772	3-3-05A	54.2	0.47	14.7	20.5	5.85
105S01773	3-8-05A	57.1	0.47	14.7	31.0	16.4

hese results only apply to the samples tested.

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Reviewed By:

Joey Sheeley, Soils Lab Supervisor

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Dugout Mine
P.O. Box 1029
Wellington, UT 84542

Client Project ID: Dugout Canyon Mine
Date Received: 03/23/05

Set #0105S01744
Report Date: 04/08/05

Lab Id	Sample Id	pH	Saturation	EC @ 25°C	Calcium	Magnesium	Sodium	SAR	Sand	Silt	Clay	Texture
		s.u.	%	dS/m	meq/L	meq/L	meq/L		%	%	%	
105S01774	3-9-05A	7.5	38.8	1.10	3.47	4.23	1.78	0.91	87.0	9.0	4.0	LOAMY SAND
105S01775	3-10-05A	7.6	39.2	1.13	3.31	4.10	2.11	1.09	80.0	14.0	6.0	LOAMY SAND
105S01776	3-11-05A	7.6	38.3	1.40	4.72	5.20	2.53	1.14	82.0	14.0	4.0	LOAMY SAND
105S01777	3-15-05A	7.8	41.0	0.73	1.73	2.00	1.91	1.40	86.0	10.0	4.0	LOAMY SAND

'hese results only apply to the samples tested.

\bbreviations for extractants: PE= Saturated Paste Extract, H20Sol= water soluble,AB-DTPA= Ammonium Bicarbonate-DTPA, AAO= Acid Ammonium Oxalate
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Reviewed By: ______________________
Joey Sheeley, Soils Lab Supervisor

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Sheridan, WY 82801

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Soil Analysis Report

Canyon Fuel Co
Dugout Mine
P.O. Box 1029
Wellington, UT 84542

Client Project ID: Dugout Canyon Mine
Date Received: 03/23/05

Set #0105S01744
Report Date: 04/08/05

Lab Id	Sample Id	Coarse Fragments	Field Capacity	Wilt Point	Available Sodium	Exchangeable Sodium	Boron	Nitrogen Nitrate	Selenium	TKN
		%	%	%	meq/100g	meq/100g	ppm	ppm	ppm	%
105S01774	3-9-05A	4.2	20.0	7.3	0.13	0.06	0.72	0.14	0.02	0.43
105S01775	3-10-05A	5.1	26.2	7.0	0.12	0.04	0.56	0.16	0.02	0.69
105S01776	3-11-05A	4.6	25.2	6.6	0.12	0.02	0.60	0.16	0.02	0.59
105S01777	3-15-05A	5.7	28.5	6.0	0.12	0.04	0.64	0.18	0.02	0.56

These results only apply to the samples tested.

Abbreviations for extractants: PE= Saturated Paste Extract, H20Sol= water soluble,AB-DTPA= Ammonium Bicarbonate-DTPA, AAO= Acid Ammonium Oxalate
Abbreviations used in acid base accounting: T/S.= Total Sulfur, AB= Acid Base, ABP= Acid Base Potential, PyrS= Pyritic Sulfur, Pyr+Org= Pyritic Sulfur + Organic Sulfur, Neut. Pot.= Neutralization Potential
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Joey Sheeley, Soils Lab Supervisor

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Sheridan, WY 82801

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Canyon Fuel Co
Dugout Mine
P.O. Box 1029
Wellington, UT 84542

Client Project ID: Dugout Canyon Mine
Date Received: 03/23/05

Set #0105S01744
Report Date: 04/08/05

Lab Id	Sample Id	TOC %	Total Sulfur %	T.S. AB t/1000t	Neutral. Pot. t/1000t	T.S. ABP t/1000t
105S01774	3-9-05A	56.5	0.49	15.3	23.7	8.38
105S01775	3-10-05A	54.9	0.48	15.0	20.4	5.42
105S01776	3-11-05A	58.6	0.50	15.6	22.4	6.79
105S01777	3-15-05A	67.5	0.52	16.2	14.1	-2.19

hese results only apply to the samples tested.

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Client Project ID: Dugout Canyon Mine
Date Received: 03/23/05

Set #0105S01744
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Lab Id	Sample Id	pH	Saturation	EC @ 25°C	Calcium	Magnesium	Sodium	SAR	Sand	Silt	Clay	Texture
		s.u.	%	dS/m	meq/L	meq/L	meq/L		%	%	%	
)105S01761	1-4-05A	7.3	40.8	1.40	6.79	6.24	1.29	0.51	86.3	8.7	5.0	LOAMY SAND
)105S01761D	1-4-05A	7.1	37.9	1.70	8.34	7.48	1.49	0.53	85.0	12.5	2.5	LOAMY SAND
)105S01770	3-1-05A	7.5	39.1	1.18	4.13	4.79	1.63	0.77	85.0	9.0	6.0	LOAMY SAND
)105S01770D	3-1-05A	7.5	38.6	1.07	3.64	4.24	1.47	0.74	89.0	5.0	6.0	SAND
)105S01772	3-3-05A	7.4	38.5	1.41	5.69	6.07	1.67	0.69	83.0	11.0	6.0	LOAMY SAND
)105S01772D	3-3-05A	7.5	41.2	1.16	4.51	4.68	1.35	0.63	85.0	9.0	6.0	LOAMY SAND
)105S01774	3-9-05A	7.5	38.8	1.10	3.47	4.23	1.78	0.91	87.0	9.0	4.0	LOAMY SAND
)105S01774D	3-9-05A	7.5	40.7	0.96	2.83	3.43	1.49	0.84	87.0	7.0	6.0	LOAMY SAND

These results only apply to the samples tested.

Abbreviations for extractants: PE= Saturated Paste Extract, H20Sol= water soluble,AB-DTPA= Ammonium Bicarbonate-DTPA, AAO= Acid Ammonium Oxalate
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Wellington, UT 84542

Client Project ID: Dugout Canyon Mine
Date Received: 03/23/05

Set #0105S01744
Report Date: 04/08/05

Lab Id	Sample Id	Coarse Fragments %	Field Capacity %	Wilt Point %	Available Sodium meq/100g	Exchangeable Sodium meq/100g	Boron ppm	Nitrogen Nitrate ppm	Selenium ppm	TKN %
105S01761	1-4-05A	4.6	20.1	5.3	0.11	0.06	0.52	0.12	0.02	0.48
105S01761D	1-4-05A		22.1	5.1	0.11	0.05	0.56	0.12	0.02	0.33
105S01770	3-1-05A	3.5	22.1	6.6	0.10	0.04	0.42	0.14	0.02	0.56
105S01770D	3-1-05A		20.9	6.1	0.09	0.03	0.50	0.16	0.02	0.38
105S01772	3-3-05A	3.7	22.2	7.1	0.10	0.04	0.50	0.16	0.02	0.33
105S01772D	3-3-05A		18.6	6.1	0.08	0.02	0.58	0.18	0.02	0.54
105S01774	3-9-05A	4.2	20.0	7.3	0.13	0.06	0.72	0.14	0.02	0.43
105S01774D	3-9-05A		16.9	6.7	0.12	0.06	0.52	0.20	0.02	0.36

These results only apply to the samples tested.

Abbreviations for extractants: PE= Saturated Paste Extract, H20Sol= water soluble,AB-DTPA= Ammonium Bicarbonate-DTPA, AAO= Acid Ammonium Oxalate
Abbreviations used in acid base accounting: T.S.= Total Sulfur, AB= Acid Base, ABP= Acid Base Potential, PyrS= Pyritic Sulfur, Pyr+Org= Pyritic Sulfur + Organic Sulfur, Neut. Pot.= Neutralization Potential
Miscellaneous Abbreviations: SAR= Sodium Adsorption Ratio, CEC= Cation Exchange Capacity, ESP= Exchangeable Sodium Percentage

Reviewed By: ____________________
Joey Sheeley, Soils Lab Supervisor

OCT 1 1 2005

Inter-Mountain Laboratories, Inc.

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Sheridan, WY 82801

Report ID: 010501744

Soil Analysis Report

Canyon Fuel Co

Dugout Mine
P.O. Box 1029
Wellington, UT 84542

Client Project ID: Dugout Canyon Mine
Date Received: 03/23/05

Set #0105S01744
Report Date: 04/08/05

Lab Id	Sample Id	TOC %	Total Sulfur %	T.S. AB t/1000t	Neutral. Pot. t/1000t	T.S. ABP t/1000t
0105S01761	1-4-05A	61.9	0.49	15.3	20.7	5.42
0105S01761D	1-4-05A	59.2	0.49	15.3	22.6	7.34
0105S01770	3-1-05A	58.7	0.53	16.6	22.4	5.80
0105S01770D	3-1-05A	58.1	0.53	16.6	22.1	5.59
0105S01772	3-3-05A	54.2	0.47	14.7	20.5	5.85
0105S01772D	3-3-05A	54.2	0.45	14.1	21.0	6.93
0105S01774	3-9-05A	56.5	0.49	15.3	23.7	8.38
0105S01774D	3-9-05A	56.9	0.49	15.3	23.2	7.93

These results only apply to the samples tested.

Abbreviations for extractants: PE= Saturated Paste Extract, H20Sol= water soluble,AB-DTPA= Ammonium Bicarbonate-DTPA, AAO= Acid Ammonium Oxalate
Abbreviations used in acid base accounting: T.S.= Total Sulfur, AB= Acid Base, ABP= Acid Base Potential, PyrS= Pyritic Sulfur, Pyr+Org= Pyritic Sulfur + Organic Sulfur, Neut. Pot.= Neutralization Potential
Miscellaneous Abbreviations: SAR= Sodium Adsorption Ratio, CEC= Cation Exchange Capacity, ESP= Exchangeable Sodium Percentage

Reviewed By: ______________________

Joey Sheeley, Soils Lab Supervisor

OCT 11 2005

Soil Analysis Report

Canyon Fuel Company, LLC.
HCR 35, Box 380
Helper, UT 84526

Report ID: S0610189001
Date: 11/29/2006
Work Order: S0610189

Project: Dugout Canyon Mine
Date Received: 10/11/2006

Lab ID	Sample ID	pH s.u.	Saturation %	Electrical Conductivity dS/m	Field Capacity %	Wilt Point %	Calcium meq/L	Magnesium meq/L	Sodium meq/L	Potassium meq/L	SAR
S0610189-001	G-11	7.9	26.7	0.38	13.3	9.6	1.97	0.94	0.49	0.08	0.41
S0610189-002	G-12	7.9	31.2	0.44	16.8	11.3	2.33	1.18	0.34	0.20	0.26
S0610189-003	G-13	7.8	33.5	0.43	18.8	12.0	2.74	0.85	0.18	0.29	0.14
S0610189-004	G-14	7.2	40.2	0.45	20.6	12.5	3.18	0.94	0.16	0.28	0.11
S0610189-005	*Refuse	7.5	45.7	2.52	9.2	4.9	14.6	12.3	2.67	0.86	0.73

These results apply only to the samples tested.

Abbreviations for extractants: PE= Saturated Paste Extract, H20Sol= water soluble,AB-DTPA= Ammonium Bicarbonate-DTPA, AAO= Acid Ammonium Oxalate
Abbreviations used in acid base accounting: T.S.= Total Sulfur, AB= Acid Base, ABP= Acid Base Potential, PyrS= Pyritic Sulfur, Pyr+Org= Pyritic Sulfur + Organic Sulfur, Neutral. Pot.= Neutralization Potential
Miscellaneous Abbreviations: SAR= Sodium Adsorption Ratio, CEC= Cation Exchange Capacity, ESP= Exchangeable Sodium Percentage

Reviewed by: Karen A Barten
Karen Barten, Soil Lab Supervisor

Soil Analysis Report

Canyon Fuel Company, LLC.
HCR 35, Box 380
Helper, UT 84526

Report ID: S0610189001

Date: 11/29/2006

Work Order: S0610189

Project: Dugout Canyon Mine

Date Received: 10/11/2006

Lab ID	Sample ID	Available Sodium meq/100g	Exchangeable Sodium meq/100g	Sand %	Silt %	Clay %	Texture
S0610189-001	G-11	0.05	0.03	34.0	35.0	31.0	Clay Loam
S0610189-002	G-12	0.06	0.05	40.0	28.0	32.0	Clay Loam
S0610189-003	G-13	0.03	0.02	39.0	31.0	30.0	Clay Loam
S0610189-004	G-14	0.04	0.04	40.0	30.0	30.0	Clay Loam
S0610189-005	* Refuse	0.19	0.07	18.0	48.0	34.0	Silty Clay Loam

INCORPORATED

FEB 13 2007

Div. of Oil, Gas & Mining

These results apply only to the samples tested.

Abbreviations for extractants: PE= Saturated Paste Extract, H20Sol= water soluble,AB-DTPA= Ammonium Bicarbonate-DTPA, AAO= Acid Ammonium Oxalate
Abbreviations used in acid base accounting: T.S.= Total Sulfur, AB= Acid Base, ABP= Acid Base Potential, PyrS= Pyritic Sulfur, Pyr+Org= Pyritic Sulfur + Organic Sulfur, Neutral. Pot.= Neutralization Potential
Miscellaneous Abbreviations: SAR= Sodium Adsorption Ratio, CEC= Cation Exchange Capacity, ESP= Exchangeable Sodium Percentage

Reviewed by: Karen A Barten

Karen Barten, Soil Lab Supervisor

Inter-Mountain Laboratories, Inc.

Soil Analysis Report
Canyon Fuel Company, LLC.
HCR 35, Box 380
Helper, UT 84526

Report ID: S0610189001

Date: 11/29/2006
Work Order: S0610189

Project: Dugout Canyon Mine
Date Received: 10/11/2006

Lab ID	Sample ID	Boron ppm	TKN %	Nitrogen Nitrate ppm	Phosphorus ppm	Selenium ppm	TOC %	Total Sulfur %	T.S. AB t/1000t	Neut. Pot. t/1000t	T.S. ABP t/1000t
S0610189-001	G-11	0.10	0.04	0.64	1.77	<0.02	<0.1	<0.01	<0.01	133	133
S0610189-002	G-12	0.15	0.06	3.55	2.27	<0.02	0.5	<0.01	<0.01	155	155
S0610189-003	G-13	0.13	0.14	0.54	1.67	<0.02	0.7	0.01	0.45	143	143
S0610189-004	G-14	0.16	0.15	5.72	4.66	<0.02	0.9	<0.01	<0.01	15.7	15.7
S0610189-005	* Refuse	0.47	1.05	0.21	0.78	0.06	58.2	0.41	12.9	10.6	-2.34

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FEB 13 2007
Div. of Oil, Gas & Mining

These results apply only to the samples tested.

Abbreviations for extractants: PE= Saturated Paste Extract, H20Sol= water soluble,AB-DTPA= Ammonium Bicarbonate-DTPA, AAO= Acid Ammonium Oxalate
Abbreviations used in acid base accounting: T.S.= Total Sulfur, AB= Acid Base, ABP= Acid Base Potential, PyrS= Pyritic Sulfur, Pyr+Org= Pyritic Sulfur + Organic Sulfur, Neutral. Pot.= Neutralization Potential
Miscellaneous Abbreviations: SAR= Sodium Adsorption Ratio, CEC= Cation Exchange Capacity, ESP= Exchangeable Sodium Percentage

Reviewed by: Karen A Barten
Karen Barten, Soil Lab Supervisor

RA ATTACHMENT 5-4

WASTE ROCK ANALYSIS

add to the back of existing information

Inter-Mountain Laboratories, Inc.
1673 Terra Avenue, Sheridan, Wyoming 82801
(307) 672-8945

Soil Analysis Report

Canyon Fuel Company, LLC.
HCR 35, Box 380
Helper, UT 84526

Report ID: S0704128001

Project: Dugout Canyon Mine
Date Received: 4/9/2007

Date: 5/28/2007
Work Order: S0704128

Lab ID	Sample ID	pH	Saturation	Electrical Conductivity	Field Capacity	Wilt Point	Calcium	Magnesium	Sodium	Potassium	SAR
		s.u.	%	dS/m	%	%	meq/L	meq/L	meq/L	meq/L	
S0704128-001	WS JAN	7.8	28.9	1.63	10.3	4.8	3.14	3.81	6.59	0.69	3.54
S0704128-002	WS FEB	8.5	28.0	0.94	9.7	4.9	0.75	0.87	6.14	0.45	6.82
S0704128-003	WS MARCH	7.9	28.3	2.25	12.4	3.5	7.43	12.3	3.41	0.96	1.09
S0704128-004	WS APRIL	7.1	28.9	2.46	14.3	5.1	8.50	11.5	4.35	1.02	1.37

These results apply only to the samples tested.

Abbreviations for extractants: PE= Saturated Paste Extract, H20Sol= water soluble,AB-DTPA= Ammonium Bicarbonate-DTPA, AAO= Acid Ammonium Oxalate

Abbreviations used in acid base accounting: T.S.= Total Sulfur, AB= Acid Base, ABP= Acid Base Potential, PyrS= Pyritic Sulfur, Pyr+Org= Pyritic Sulfur + Organic Sulfur, Neutral. Pot.= Neutralization Potential

Miscellaneous Abbreviations: SAR= Sodium Adsorption Ratio, CEC= Cation Exchange Capacity, ESP= Exchangeable Sodium Percentage

Reviewed by: Karen A Secor
Karen Secor, Soil Lab Supervisor

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Soil Analysis Report

Canyon Fuel Company, LLC.
HCR 35, Box 380
Helper, UT 84526

Report ID: S0704128001

Project: Dugout Canyon Mine
Date Received: 4/9/2007

Date: 5/28/2007
Work Order: S0704128

Lab ID	Sample ID	Available Sodium meq/100g	Exchangeable Sodium meq/100g	Sand %	Silt %	Clay %	Texture
S0704128-001	WS JAN	0.50	0.31	72.0	15.0	13.0	Sandy Loam
S0704128-002	WS FEB	0.82	0.64	70.0	17.0	13.0	Sandy Loam
S0704128-003	WS MARCH	0.19	0.10	81.0	13.0	6.0	Loamy Sand
S0704128-004	WS APRIL	0.33	0.20	75.0	14.0	11.0	Sandy Loam

These results apply only to the samples tested.

Abbreviations for extractants: PE= Saturated Paste Extract, H20Sol= water soluble,AB-DTPA= Ammonium Bicarbonate-DTPA, AAO= Acid Ammonium Oxalate
Abbreviations used in acid base accounting: T.S.= Total Sulfur, AB= Acid Base, ABP= Acid Base Potential, PyrS= Pyritic Sulfur, Pyr+Org= Pyritic Sulfur + Organic Sulfur, Neutral. Pot.= Neutralization Potential
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Reviewed by: Karen A Secor
Karen Secor, Soil Lab Supervisor

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Soil Analysis Report

Canyon Fuel Company, LLC.
HCR 35, Box 380
Helper, UT 84526

Report ID: S0704128001

Project: Dugout Canyon Mine
Date Received: 4/9/2007

Date: 5/28/2007
Work Order: S0704128

Lab ID	Sample ID	Boron	TKN	Nitrogen Nitrate	Phosphorus	Selenium
		ppm	%	ppm	ppm	ppm
S0704128-001	WS JAN	0.43	0.09	0.18	0.51	<0.02
S0704128-002	WS FEB	0.64	0.06	0.17	2.59	0.02
S0704128-003	WS MARCH	0.33	0.01	0.19	0.56	0.04
S0704128-004	WS APRIL	0.68	0.20	0.09	0.40	0.05

These results apply only to the samples tested.

Abbreviations for extractants: PE= Saturated Paste Extract, H20Sol= water soluble,AB-DTPA= Ammonium Bicarbonate-DTPA, AAO= Acid Ammonium Oxalate
Abbreviations used in acid base accounting: T.S.= Total Sulfur, AB= Acid Base, ABP= Acid Base Potential, PyrS= Pyritic Sulfur, Pyr+Org= Pyritic Sulfur + Organic Sulfur, Neutral. Pot.= Neutralization Potential
Miscellaneous Abbreviations: SAR= Sodium Adsorption Ratio, CEC= Cation Exchange Capacity, ESP= Exchangeable Sodium Percentage

Reviewed by: Karen A Secor
Karen Secor, Soil Lab Supervisor

Inter-Mountain Laboratories, Inc.
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Soil Analysis Report

Canyon Fuel Company, LLC.
HCR 35, Box 380
Helper, UT 84526

Report ID: S0704128001

Project: Dugout Canyon Mine
Date Received: 4/9/2007

Date: 5/28/2007
Work Order: S0704128

Lab ID	Sample ID	Total Carbon %	TOC %	Total Sulfur %	T.S. AB t/1000t	Neut. Pot. t/1000t	T.S. ABP t/1000t
S0704128-001	WS JAN	7.7	6.7	1.28	39.8	82.9	43.1
S0704128-002	WS FEB	7.9	5.7	0.99	31.0	190	159
S0704128-003	WS MARCH	2.6	1.2	0.23	7.14	114	107
S0704128-004	WS APRIL	12.3	11.8	0.70	21.8	38.4	16.6

These results apply only to the samples tested.

Abbreviations for extractants: PE= Saturated Paste Extract, H20Sol= water soluble,AB-DTPA= Ammonium Bicarbonate-DTPA, AAO= Acid Ammonium Oxalate
Abbreviations used in acid base accounting: T.S.= Total Sulfur, AB= Acid Base, ABP= Acid Base Potential, PyrS= Pyritic Sulfur, Pyr+Org= Pyritic Sulfur + Organic Sulfur, Neutral. Pot.= Neutralization Potential
Miscellaneous Abbreviations: SAR= Sodium Adsorption Ratio, CEC= Cation Exchange Capacity, ESP= Exchangeable Sodium Percentage

Reviewed by: Karen A Secor
Karen Secor, Soil Lab Supervisor

Inter-Mountain Laboratories, Inc.
1673 Terra Avenue, Sheridan, Wyoming 82801
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Soil Analysis Report

Canyon Fuel Company

Dugout Canyon Mine
P.O. Box 1029
Wellington, UT 84542

Report ID: S0706035001

Date: 7/10/2007

Work Order: S0706035

Project: Dugout Canyon Mine

Date Received: 6/4/2007

Lab ID	Sample ID	pH	Saturation	Electrical Conductivity	Field Capacity	Wilt Point	Calcium	Magnesium	Sodium	Potassium	SAR
		s.u.	%	dS/m	%	%	meq/L	meq/L	meq/L	meq/L	
S0706035-001	WS May	8.2	26.5	1.86	12	10	4.29	4.75	9.25	0.85	4.35

These results apply only to the samples tested.

Abbreviations for extractants: PE= Saturated Paste Extract, H20Sol= water soluble,AB-DTPA= Ammonium Bicarbonate-DTPA, AAO= Acid Ammonium Oxalate

Abbreviations used in acid base accounting: T.S.= Total Sulfur, AB= Acid Base, ABP= Acid Base Potential, PyrS= Pyritic Sulfur, Pyr+Org= Pyritic Sulfur + Organic Sulfur, Neutral. Pot.= Neutralization Potential

Miscellaneous Abbreviations: SAR= Sodium Adsorption Ratio, CEC= Cation Exchange Capacity, ESP= Exchangeable Sodium Percentage

Reviewed by: Karen A Secor

Karen Secor, Soil Lab Supervisor

Inter-Mountain Laboratories, Inc.
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Soil Analysis Report

Canyon Fuel Company

Dugout Canyon Mine
P.O. Box 1029
Wellington, UT 84542

Report ID: S0706035001

Project: Dugout Canyon Mine
Date Received: 6/4/2007

Date: 7/10/2007
Work Order: S0706035

Lab ID	Sample ID	Available Sodium meq/100g	Exchangeable Sodium meq/100g	Sand %	Silt %	Clay %	Texture
S0706035-001	WS May	1.42	1.18	74.0	20.0	6.0	Sandy Loam

These results apply only to the samples tested.

Abbreviations for extractants: PE= Saturated Paste Extract, H20Sol= water soluble,AB-DTPA= Ammonium Bicarbonate-DTPA, AAO= Acid Ammonium Oxalate
Abbreviations used in acid base accounting: T.S.= Total Sulfur, AB= Acid Base, ABP= Acid Base Potential, PyrS= Pyritic Sulfur, Pyr+Org= Pyritic Sulfur + Organic Sulfur, Neutral. Pot.= Neutralization Potential
Miscellaneous Abbreviations: SAR= Sodium Adsorption Ratio, CEC= Cation Exchange Capacity, ESP= Exchangeable Sodium Percentage

Reviewed by: Karen A Secor
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Soil Analysis Report

Canyon Fuel Company

Dugout Canyon Mine
P.O. Box 1029
Wellington, UT 84542

Report ID: S0706035001

Date: 7/10/2007

Work Order: S0706035

Project: Dugout Canyon Mine

Date Received: 6/4/2007

				Nitrogen		
		Boron	TKN	Nitrate	Phosphorus	Selenium
Lab ID	**Sample ID**	ppm	%	ppm	ppm	ppm
S0706035-001	WS May	0.36	0.17	0.12	2.15	<0.02

These results apply only to the samples tested.

Abbreviations for extractants: PE= Saturated Paste Extract, H20Sol= water soluble,AB-DTPA= Ammonium Bicarbonate-DTPA, AAO= Acid Ammonium Oxalate

Abbreviations used in acid base accounting: T.S.= Total Sulfur, AB= Acid Base, ABP= Acid Base Potential, PyrS= Pyritic Sulfur, Pyr+Org= Pyritic Sulfur + Organic Sulfur, Neutral. Pot.= Neutralization Potential

Miscellaneous Abbreviations: SAR= Sodium Adsorption Ratio, CEC= Cation Exchange Capacity, ESP= Exchangeable Sodium Percentage

Reviewed by: Karen A Secor

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Inter-Mountain Laboratories, Inc.
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Soil Analysis Report

Canyon Fuel Company
Dugout Canyon Mine
P.O. Box 1029
Wellington, UT 84542

Report ID: S0706035001
Date: 7/10/2007
Work Order: S0706035

Project: Dugout Canyon Mine
Date Received: 6/4/2007

Lab ID	Sample ID	Total Sulfur	T.S. AB	Neut. Pot.	T.S. ABP	Sulfate Sulfur	Pyritic Sulfur	Organic Sulfur	Total Carbon	TOC
		%	t/1000t	t/1000t	t/1000t	%	%	%	%	%
S0706035-001	WS May	0.85	26.4	165	138	<0.01	0.70	0.15	17.3	15.3

These results apply only to the samples tested.

Abbreviations for extractants: PE= Saturated Paste Extract, H20Sol= water soluble,AB-DTPA= Ammonium Bicarbonate-DTPA, AAO= Acid Ammonium Oxalate
Abbreviations used in acid base accounting: T.S.= Total Sulfur, AB= Acid Base, ABP= Acid Base Potential, PyrS= Pyritic Sulfur, Pyr+Org= Pyritic Sulfur + Organic Sulfur, Neutral. Pot.= Neutralization Potential
Miscellaneous Abbreviations: SAR= Sodium Adsorption Ratio, CEC= Cation Exchange Capacity, ESP= Exchangeable Sodium Percentage

Reviewed by: Karen A Secor
Karen Secor, Soil Lab Supervisor

RA ATTACHMENT 5-4
WASTE ROCK ANALYSIS

INTER-MOUNTAIN LABS

Inter-Mour aboratories, Inc.
1673 Terra Avenue, Sheri..., Wyoming 82801
(800) - 828-1097

Soil Analysis Report

Canyon Fuel Company, LLC.
HCR 35, Box 380
Helper, UT 84526

Report ID: S0612270001

Project: Dugout Canyon Mine
Date Received: 12/14/2006

Date: 3/2/2007
Work Order: S0612270

Lab ID	Sample ID	pH	Saturation	Electrical Conductivity	Field Capacity	Wilt Point	Calcium	Magnesium	Sodium	Potassium	SAR
		s.u.	%	dS/m	%	%	meq/L	meq/L	meq/L	meq/L	
S0612270-001	WS Nov.	7.3	27.1	1.63	14	7.1	7.00	8.16	5.57	1.41	2.02
S0612270-002	WS Dec.	7.9	25.3	1.27	14	6.8	2.04	1.86	11.7	0.92	8.35

These results apply only to the samples tested.

Abbreviations for extractants: PE= Saturated Paste Extract, H20Sol= water soluble,AB-DTPA= Ammonium Bicarbonate-DTPA, AAO= Acid Ammonium Oxalate
Abbreviations used in acid base accounting: T.S.= Total Sulfur, AB= Acid Base, ABP= Acid Base Potential, PyrS= Pyritic Sulfur, Pyr+Org= Pyritic Sulfur + Organic Sulfur, Neutral. Pot.= Neutralization Potential
Miscellaneous Abbreviations: SAR= Sodium Adsorption Ratio, CEC= Cation Exchange Capacity, ESP= Exchangeable Sodium Percentage

Reviewed by: Karen A Barten
Karen Barten, Soil Lab Supervisor

INTER-MOUNTAIN LABS

Inter-Moun[illegible] [illegible]boratories, Inc.
1673 Terra Avenue, Sheri[illegible], Wyoming 82801
(800) - 828-1097

Soil Analysis Report

Canyon Fuel Company, LLC.
HCR 35, Box 380
Helper, UT 84526

Report ID: S0612270001

Project: Dugout Canyon Mine
Date Received: 12/14/2006

Date: 3/2/2007
Work Order: S0612270

Lab ID	Sample ID	Available Sodium meq/100g	Exchangeable Sodium meq/100g	Sand %	Silt %	Clay %	Texture
S0612270-001	WS Nov.	0.36	0.21	62.0	28.0	10.0	Sandy Loam
S0612270-002	WS Dec.	0.86	0.57	70.0	19.0	11.0	Sandy Loam

These results apply only to the samples tested.

Abbreviations for extractants: PE= Saturated Paste Extract, H20Sol= water soluble,AB-DTPA= Ammonium Bicarbonate-DTPA, AAO= Acid Ammonium Oxalate
Abbreviations used in acid base accounting: T.S.= Total Sulfur, AB= Acid Base, ABP= Acid Base Potential, PyrS= Pyritic Sulfur, Pyr+Org= Pyritic Sulfur + Organic Sulfur, Neutral. Pot.= Neutralization Potential
Miscellaneous Abbreviations: SAR= Sodium Adsorption Ratio, CEC= Cation Exchange Capacity, ESP= Exchangeable Sodium Percentage

Reviewed by: Karen A Barten

Karen Barten, Soil Lab Supervisor

Inter-Mount boratories, Inc.
1673 Terra Avenue, Sherio..., Wyoming 82801
(800) - 828-1097

Soil Analysis Report

Canyon Fuel Company, LLC.
HCR 35, Box 380
Helper, UT 84526

Report ID: S0612270001
Date: 3/2/2007
Work Order: S0612270

Project: Dugout Canyon Mine
Date Received: 12/14/2006

Lab ID	Sample ID	Boron	TKN	Nitrogen Nitrate	Phosphorus	Selenium
		ppm	%	ppm	ppm	ppm
S0612270-001	WS Nov.	0.99	2.59	0.37	0.57	0.06
S0612270-002	WS Dec.	1.41	0.80	0.35	1.09	0.05

These results apply only to the samples tested.

Abbreviations for extractants: PE= Saturated Paste Extract, H20Sol= water soluble,AB-DTPA= Ammonium Bicarbonate-DTPA, AAO= Acid Ammonium Oxalate
Abbreviations used in acid base accounting: T.S.= Total Sulfur, AB= Acid Base, ABP= Acid Base Potential, PyrS= Pyritic Sulfur, Pyr+Org= Pyritic Sulfur + Organic Sulfur, Neutral. Pot.= Neutralization Potential
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Reviewed by: Karen A Barten

Karen Barten, Soil Lab Supervisor

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Soil Analysis Report

Canyon Fuel Company, LLC.
HCR 35, Box 380
Helper, UT 84526

Report ID: S0612270001
Date: 3/2/2007
Work Order: S0612270

Project: Dugout Canyon Mine
Date Received: 12/14/2006

Lab ID	Sample ID	Total Carbon %	TOC %	Total Sulfur %	T.S. AB t/1000t	Neut. Pot. t/1000t	T.S. ABP t/1000t
S0612270-001	WS Nov.	2.0	1.2	0.44	13.9	67.3	53.4
S0612270-002	WS Dec.	4.9	4.4	1.46	45.7	41.5	-4.21

These results apply only to the samples tested.

Abbreviations for extractants: PE= Saturated Paste Extract, H20Sol= water soluble,AB-DTPA= Ammonium Bicarbonate-DTPA, AAO= Acid Ammonium Oxalate
Abbreviations used in acid base accounting: T.S.= Total Sulfur, AB= Acid Base, ABP= Acid Base Potential, PyrS= Pyritic Sulfur, Pyr+Org= Pyritic Sulfur + Organic Sulfur, Neutral. Pot.= Neutralization Potential
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Reviewed by: Karen A Barten
Karen Barten, Soil Lab Supervisor

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1673 Terra Avenue, Sheridan, Wyoming 82801
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Soil Analysis Report

Canyon Fuel Company

Dugout Canyon Mine
P.O. Box 1029
Wellington, UT 84542

Report ID: S0707474001

Project: Dugout Canyon Mine
Date Received: 7/26/2007

Date: 8/24/2007
Work Order: S0707474

Lab ID	Sample ID	Depths cm	pH s.u.	Saturation %	Electrical Conductivity dS/m	Field Capacity %	Wilt Point %
S0707474-001	Staging Area SP-1	0-18	6.4	48.4	0.54	17	14
S0707474-002	Staging Area SP-1	18-61	6.5	35.4	0.31	15	11
S0707474-003	Staging Area SP-1	61-162	6.8	37.1	0.28	15	12
S0707474-004	WR-July	-	7.4	25.4	2.12	9.4	5.5
S0707474-005	G-15 Topsoil	-	7.7	32.0	0.42	15	10

Staging Area SP-1 sampling site is located in E1/2SW1/4SW1/4 of Section 16, Township 13S Range 13E

These results apply only to the samples tested.

Abbreviations for extractants: PE= Saturated Paste Extract, H20Sol= water soluble,AB-DTPA= Ammonium Bicarbonate-DTPA, AAO= Acid Ammonium Oxalate
Abbreviations used in acid base accounting: T.S.= Total Sulfur, AB= Acid Base, ABP= Acid Base Potential, PyrS= Pyritic Sulfur, Pyr+Org= Pyritic Sulfur + Organic Sulfur, Neutral. Pot.= Neutralization Potential
Miscellaneous Abbreviations: SAR= Sodium Adsorption Ratio, CEC= Cation Exchange Capacity, ESP= Exchangeable Sodium Percentage

Reviewed by: Karen A Secor
Karen Secor, Soil Lab Supervisor

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Soil Analysis Report

Canyon Fuel Company

Dugout Canyon Mine
P.O. Box 1029
Wellington, UT 84542

Report ID: S0707474001

Project: Dugout Canyon Mine

Date Received: 7/26/2007

Date: 8/24/2007

Work Order: S0707474

Lab ID	Sample ID	Depths cm	Calcium meq/L	Magnesium meq/L	Sodium meq/L	Potassium meq/L	SAR	Available Sodium meq/100g	Exchangeable Sodium meq/100g
S0707474-001	Staging Area SP-1	0-18	4.03	1.40	0.27	0.75	0.17	0.02	<0.01
S0707474-002	Staging Area SP-1	18-61	2.14	0.74	0.29	0.42	0.25	0.02	0.01
S0707474-003	Staging Area SP-1	61-162	1.72	0.67	0.19	0.37	0.17	0.02	0.01
S0707474-004	WR-July	-	10.4	12.1	4.28	0.99	1.28	0.24	0.13
S0707474-005	G-15 Topsoil	-	2.73	0.98	0.86	0.25	0.63	0.03	<0.01

These results apply only to the samples tested.

Abbreviations for extractants: PE= Saturated Paste Extract, H20Sol= water soluble,AB-DTPA= Ammonium Bicarbonate-DTPA, AAO= Acid Ammonium Oxalate
Abbreviations used in acid base accounting: T.S.= Total Sulfur, AB= Acid Base, ABP= Acid Base Potential, PyrS= Pyritic Sulfur, Pyr+Org= Pyritic Sulfur + Organic Sulfur, Neutral. Pot.= Neutralization Potential
Miscellaneous Abbreviations: SAR= Sodium Adsorption Ratio, CEC= Cation Exchange Capacity, ESP= Exchangeable Sodium Percentage

Reviewed by: Karen A Secor

Karen Secor, Soil Lab Supervisor

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1673 Terra Avenue, Sheridan, Wyoming 82801
(307) 672-8945

Soil Analysis Report
Canyon Fuel Company
Dugout Canyon Mine
P.O. Box 1029
Wellington, UT 84542

Report ID: S0707474001

Project: Dugout Canyon Mine
Date Received: 7/26/2007

Date: 8/24/2007
Work Order: S0707474

Lab ID	Sample ID	Depths cm	Sand %	Silt %	Clay %	Texture	Coarse Fragment %
S0707474-001	Staging Area SP-1	0-18	40.0	35.0	25.0	Loam	32.1
S0707474-002	Staging Area SP-1	18-61	45.0	29.0	26.0	Loam	40.5
S0707474-003	Staging Area SP-1	61-162	47.0	25.0	28.0	Sandy Clay Loam	30.4
S0707474-004	WR-July	-	76.0	15.0	9.0	Sandy Loam	76.8
S0707474-005	G-15 Topsoil	-	40.0	36.0	24.0	Loam	25.7

These results apply only to the samples tested.

Abbreviations for extractants: PE= Saturated Paste Extract, H20Sol= water soluble,AB-DTPA= Ammonium Bicarbonate-DTPA, AAO= Acid Ammonium Oxalate
Abbreviations used in acid base accounting: T.S.= Total Sulfur, AB= Acid Base, ABP= Acid Base Potential, PyrS= Pyritic Sulfur, Pyr+Org= Pyritic Sulfur + Organic Sulfur, Neutral. Pot.= Neutralization Potential
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Reviewed by: Karen A Secor
Karen Secor, Soil Lab Supervisor

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Soil Analysis Report
Canyon Fuel Company
Dugout Canyon Mine
P.O. Box 1029
Wellington, UT 84542

Report ID: S0707474001

Project: Dugout Canyon Mine
Date Received: 7/26/2007

Date: 8/24/2007
Work Order: S0707474

Lab ID	Sample ID	Depths cm	Boron ppm	TKN %	Nitrogen Nitrate ppm	Phosphorus ppm	Selenium ppm
S0707474-001	Staging Area SP-1	0-18	0.43	0.23	9.11	28.8	<0.02
S0707474-002	Staging Area SP-1	18-61	0.24	0.07	3.29	2.92	<0.02
S0707474-003	Staging Area SP-1	61-162	0.24	0.06	1.66	2.12	<0.02
S0707474-004	WR-July	-	0.94	0.19	0.24	0.51	0.03
S0707474-005	G-15 Topsoil	-	0.36	0.08	3.76	1.81	<0.02

These results apply only to the samples tested.

Abbreviations for extractants: PE= Saturated Paste Extract, H20Sol= water soluble,AB-DTPA= Ammonium Bicarbonate-DTPA, AAO= Acid Ammonium Oxalate
Abbreviations used in acid base accounting: T.S.= Total Sulfur, AB= Acid Base, ABP= Acid Base Potential, PyrS= Pyritic Sulfur, Pyr+Org= Pyritic Sulfur + Organic Sulfur, Neutral. Pot.= Neutralization Potential
Miscellaneous Abbreviations: SAR= Sodium Adsorption Ratio, CEC= Cation Exchange Capacity, ESP= Exchangeable Sodium Percentage

Reviewed by: Karen A Secor
Karen Secor, Soil Lab Supervisor

Inter-Mountain L.   ories, Inc.
1673 Terra Avenue, Sheridan, Wyoming 82801
(307) 672-8945

Soil Analysis Report
Canyon Fuel Company
Dugout Canyon Mine
P.O. Box 1029
Wellington, UT 84542

Report ID: S0707474001
Date: 8/24/2007
Work Order: S0707474

Project: Dugout Canyon Mine
Date Received: 7/26/2007

Lab ID	Sample ID	Depths cm	Total Carbon %	TOC %	Total Sulfur %	T.S. AB t/1000t	Neut. Pot. t/1000t	T.S. ABP t/1000t
S0707474-001	Staging Area SP-1	0-18	3.0	2.9	0.02	0.72	5.41	4.69
S0707474-002	Staging Area SP-1	18-61	1.0	0.9	<0.01	<0.01	4.20	4.20
S0707474-003	Staging Area SP-1	61-162	0.6	0.5	0.01	0.40	6.57	6.17
S0707474-004	WR-July	-	11.7	11.0	0.63	19.7	54.1	34.4
S0707474-005	G-15 Topsoil	-	4.1	1.3	0.02	0.51	232	231

Staging Area SP-1 sampling site is located in E1/2SW1/4SW1/4 of Section 16, Township 13S Range 13E

These results apply only to the samples tested.

Abbreviations for extractants: PE= Saturated Paste Extract, H20Sol= water soluble,AB-DTPA= Ammonium Bicarbonate-DTPA, AAO= Acid Ammonium Oxalate
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Reviewed by: Karen A Secor
Karen Secor, Soil Lab Supervisor

RA ATTACHMENT 5-4
WASTE ROCK ANALYSIS

Canyon Fuel Company, LLC
Dugout Canyon Mine

Refuse Pile Amendment
October 10, 2008

Soil Analysis Report

Waste Rock Analysis

WS Feb = Feb 2008
WS April = April 2008
WS May = May 2008
WS June = June 2008
WS July = July 2008

WR Aug #1 & #2 = August 2007
WR Sept = Sept 2007
WR October = October 2007
WR Nov = Nov 2007
WR Client = Not relevant to Dugout sampling commitment
WS Dec = Dec 2007 - Acid Base Accounting for Dec 2007 sample Requested by Pricilla Burton

Inter-Mountain Laboratories, Inc.
1673 Terra Avenue, Sheridan, Wyoming 82801
(307) 672-8945

Soil Analysis Report
Canyon Fuel Company
Dugout Canyon Mine
P.O. Box 1029
Wellington, UT 84542

Report ID: S0711471001

Project: Dugout Canyon Mine
Date Received: 11/28/2007

Date Reported: 1/11/2008
Work Order: S0711471

Lab ID	Sample ID	pH	Saturation	Electrical Conductivity	Field Capacity	Wilt Point	Calcium	Magnesium	Sodium	Potassium	SAR
		s.u.	%	dS/m	%	%	meq/L	meq/L	meq/L	meq/L	
S0711471-001	WR Aug #1	8.0	28.2	1.47	10	4.8	2.90	3.48	8.04	0.86	4.50
S0711471-002	WR Aug #2	8.1	30.4	1.00	10	4.6	1.29	1.77	5.71	0.59	4.62
S0711471-003	WR Sept	7.8	26.4	1.52	10	4.5	2.56	3.10	8.32	0.69	4.95
S0711471-004	WR October	8.2	28.4	1.13	10	10	1.46	1.63	7.71	0.61	6.20
S0711471-005	WR Nov	8.0	31.3	2.52	11	10	6.46	7.21	12.2	2.17	4.66
S0711471-006	WR-Client	7.4	28.3	3.60	10	4.6	19.1	19.0	8.14	0.84	1.87

SEP 3 0 2008

These results apply only to the samples tested.

Abbreviations for extractants: PE= Saturated Paste Extract, H20Sol= water soluble,AB-DTPA= Ammonium Bicarbonate-DTPA, AAO= Acid Ammonium Oxalate
Abbreviations used in acid base accounting: T.S.= Total Sulfur, AB= Acid Base, ABP= Acid Base Potential, PyrS= Pyritic Sulfur, Pyr+Org= Pyritic Sulfur + Organic Sulfur, Neutral. Pot.= Neutralization Potential
Miscellaneous Abbreviations: SAR= Sodium Adsorption Ratio, CEC= Cation Exchange Capacity, ESP= Exchangeable Sodium Percentage

Reviewed by: Karen A Secor
Karen Secor, Soil Lab Supervisor

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Soil Analysis Report

Canyon Fuel Company

Dugout Canyon Mine
P.O. Box 1029
Wellington, UT 84542

Report ID: S0711471001

Project: Dugout Canyon Mine
Date Received: 11/28/2007

Date Reported: 1/11/2008
Work Order: S0711471

Lab ID	Sample ID	Sand %	Silt %	Clay %	Texture	Coarse Fragment %	Available Sodium meq/100g	Exchangeable Sodium meq/100g
S0711471-001	WR Aug #1	76.0	14.0	10.0	Sandy Loam	<0.01	0.82	0.59
S0711471-002	WR Aug #2	80.0	14.0	6.0	Loamy Sand	<0.01	0.69	0.52
S0711471-003	WR Sept	82.0	12.0	6.0	Loamy Sand	<0.01	0.73	0.51
S0711471-004	WR October	77.0	16.0	7.0	Loamy Sand	<0.01	1.02	0.80
S0711471-005	WR Nov	78.0	16.0	6.0	Loamy Sand	<0.01	1.46	1.08
S0711471-006	WR-Client	79.0	14.0	7.0	Loamy Sand	3.88	0.41	0.18

SEP 30 2008

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Abbreviations for extractants: PE= Saturated Paste Extract, H20Sol= water soluble,AB-DTPA= Ammonium Bicarbonate-DTPA, AAO= Acid Ammonium Oxalate
Abbreviations used in acid base accounting: T.S.= Total Sulfur, AB= Acid Base, ABP= Acid Base Potential, PyrS= Pyritic Sulfur, Pyr+Org= Pyritic Sulfur + Organic Sulfur, Neutral. Pot.= Neutralization Potential
Miscellaneous Abbreviations: SAR= Sodium Adsorption Ratio, CEC= Cation Exchange Capacity, ESP= Exchangeable Sodium Percentage

Reviewed by: Karen A Secor
Karen Secor, Soil Lab Supervisor

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Soil Analysis Report

Canyon Fuel Company

Dugout Canyon Mine
P.O. Box 1029
Wellington, UT 84542

Report ID: S0711471001

Project: Dugout Canyon Mine
Date Received: 11/28/2007

Date Reported: 1/11/2008
Work Order: S0711471

		Nitrogen				
		TKN	Nitrate	Phosphorus	Boron	Selenium
Lab ID	**Sample ID**	%	ppm	ppm	ppm	ppm
S0711471-001	WR Aug #1	<0.01	0.10	1.90	0.47	<0.02
S0711471-002	WR Aug #2	<0.01	0.18	2.17	0.44	<0.02
S0711471-003	WR Sept	<0.01	<0.02	1.80	0.46	<0.02
S0711471-004	WR October	<0.01	<0.02	2.03	0.31	<0.02
S0711471-005	WR Nov	<0.01	0.05	2.30	0.17	<0.02
S0711471-006	WR-Client	0.04	<0.02	1.97	0.29	0.44

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Miscellaneous Abbreviations: SAR= Sodium Adsorption Ratio, CEC= Cation Exchange Capacity, ESP= Exchangeable Sodium Percentage

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Karen Secor, Soil Lab Supervisor

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Soil Analysis Report
Canyon Fuel Company
Dugout Canyon Mine
P.O. Box 1029
Wellington, UT 84542

Report ID: S0711471001

Project: Dugout Canyon Mine
Date Received: 11/28/2007

Date Reported: 1/11/2008
Work Order: S0711471

Lab ID	Sample ID	Total Sulfur	T.S. AB	Neut. Pot.	T.S. ABP	Sulfate Sulfur	Pyritic Sulfur	Organic Sulfur	PyriticS AB	PyriticS ABP	Total Carbon
		%	t/1000t	t/1000t	t/1000t	%	%	%	t/1000t	t/1000t	%
S0711471-001	WR Aug #1	0.91	28.3	135	107	0.05	0.69	0.17	21.5	114	9.7
S0711471-002	WR Aug #2	0.39	12.3	124	111	<0.01	0.25	0.15	7.75	116	10.9
S0711471-003	WR Sept	0.78	24.2	80.2	56.0	0.10	0.46	0.22	14.4	65.8	9.2
S0711471-004	WR October	0.35	11.1	175	164	0.03	0.11	0.22	3.27	172	14.6
S0711471-005	WR Nov	0.45	13.9	198	184	0.06	0.22	0.17	6.85	191	19.2
S0711471-006	WR-Client	1.14	35.5	125	89.3	0.14	0.80	0.19	25.0	99.9	13.9

SEP 3 0 2008

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Abbreviations used in acid base accounting: T.S.= Total Sulfur, AB= Acid Base, ABP= Acid Base Potential, PyrS= Pyritic Sulfur, Pyr+Org= Pyritic Sulfur + Organic Sulfur, Neutral. Pot.= Neutralization Potential
Miscellaneous Abbreviations: SAR= Sodium Adsorption Ratio, CEC= Cation Exchange Capacity, ESP= Exchangeable Sodium Percentage

Reviewed by: Karen A Secor
Karen Secor, Soil Lab Supervisor

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Soil Analysis Report

Canyon Fuel Company
Dugout Canyon Mine
P.O. Box 1029
Wellington, UT 84542

Report ID: S0711471001

Project: Dugout Canyon Mine
Date Received: 11/28/2007

Date Reported: 1/11/2008
Work Order: S0711471

Lab ID	Sample ID	TOC %
S0711471-001	WR Aug #1	8.1
S0711471-002	WR Aug #2	9.4
S0711471-003	WR Sept	8.3
S0711471-004	WR October	12.5
S0711471-005	WR Nov	16.8
S0711471-006	WR-Client	12.4

These results apply only to the samples tested.

Abbreviations for extractants: PE= Saturated Paste Extract, H20Sol= water soluble,AB-DTPA= Ammonium Bicarbonate-DTPA, AAO= Acid Ammonium Oxalate
Abbreviations used in acid base accounting: T.S.= Total Sulfur, AB= Acid Base, ABP= Acid Base Potential, PyrS= Pyritic Sulfur, Pyr+Org= Pyritic Sulfur + Organic Sulfur, Neutral. Pot.= Neutralization Potential
Miscellaneous Abbreviations: SAR= Sodium Adsorption Ratio, CEC= Cation Exchange Capacity, ESP= Exchangeable Sodium Percentage

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Soil Analysis Report
Canyon Fuel Company
Dugout Canyon Mine
P.O. Box 1029
Wellington, UT 84542

Report ID: S0804032001

Project: Dugout Canyon Mine
Date Received: 4/2/2008

Date Reported: 4/9/2008
Work Order: S0804032

Lab ID	Sample ID	Total Sulfur	T.S. AB	Neut. Pot.	T.S. ABP	Sulfate Sulfur	Pyritic Sulfur	Organic Sulfur	PyriticS AB	PyriticS ABP
		%	t/1000t	t/1000t	t/1000t	%	%	%	t/1000t	t/1000t
S0804032-001	WS Dec	1.28	40.1	144	103	0.03	0.93	0.32	29.2	114

SEP 3 0 2008

These results apply only to the samples tested.

Abbreviations for extractants: PE= Saturated Paste Extract, H20Sol= water soluble,AB-DTPA= Ammonium Bicarbonate-DTPA, AAO= Acid Ammonium Oxalate
Abbreviations used in acid base accounting: T.S.= Total Sulfur, AB= Acid Base, ABP= Acid Base Potential, PyrS= Pyritic Sulfur, Pyr+Org= Pyritic Sulfur + Organic Sulfur, Neutral. Pot.= Neutralization Potential
Miscellaneous Abbreviations: SAR= Sodium Adsorption Ratio, CEC= Cation Exchange Capacity, ESP= Exchangeable Sodium Percentage

Reviewed by: Karen A Secor
Karen Secor, Soil Lab Supervisor

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Soil Analysis Report

Canyon Fuel Company

Dugout Canyon Mine
P.O. Box 1029
Wellington, UT 84542

Report ID: S0805438001

Project: Dugout Canyon Mine
Date Received: 5/27/2008

Date Reported: 6/23/2008
Work Order: S0805438

Lab ID	Sample ID	pH	Saturation	Electrical Conductivity	Field Capacity	Wilt Point	Calcium	Magnesium	Sodium	Potassium	SAR
		s.u.	%	dS/m	%	%	meq/L	meq/L	meq/L	meq/L	
S0805438-001	WS Feb	8.3	25.3	0.81	16	5.9	1.12	0.84	5.42	0.48	5.48
S0805438-002	WS April	8.2	25.2	0.84	16	6.1	1.02	0.84	5.59	0.50	5.80
S0805438-003	WS May	8.6	29.6	0.61	16	4.0	0.36	0.23	5.22	0.23	9.63

SEP 30 2008

These results apply only to the samples tested.

Abbreviations for extractants: PE= Saturated Paste Extract, H20Sol= water soluble,AB-DTPA= Ammonium Bicarbonate-DTPA, AAO= Acid Ammonium Oxalate
Abbreviations used in acid base accounting: T.S.= Total Sulfur, AB= Acid Base, ABP= Acid Base Potential, PyrS= Pyritic Sulfur, Pyr+Org= Pyritic Sulfur + Organic Sulfur, Neutral. Pot.= Neutralization Potential
Miscellaneous Abbreviations: SAR= Sodium Adsorption Ratio, CEC= Cation Exchange Capacity, ESP= Exchangeable Sodium Percentage

Reviewed by: Karen A Secor
Karen Secor, Soil Lab Supervisor

Inter-Mountain Laboratories, Inc.
1673 Terra Avenue, Sheridan, Wyoming 82801
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Soil Analysis Report

Canyon Fuel Company

Dugout Canyon Mine
P.O. Box 1029
Wellington, UT 84542

Report ID: S0805438001

Project: Dugout Canyon Mine
Date Received: 5/27/2008

Date Reported: 6/23/2008
Work Order: S0805438

Lab ID	Sample ID	Sand %	Silt %	Clay %	Texture	Available Sodium meq/100g	Exchangeable Sodium meq/100g
S0805438-001	WS Feb	73.0	19.0	8.0	Sandy Loam	1.28	1.15
S0805438-002	WS April	73.0	20.0	7.0	Sandy Loam	0.76	0.62
S0805438-003	WS May	83.0	12.0	5.0	Loamy Sand	0.99	0.83

SEP 3 0 2008

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Abbreviations for extractants: PE= Saturated Paste Extract, H20Sol= water soluble,AB-DTPA= Ammonium Bicarbonate-DTPA, AAO= Acid Ammonium Oxalate
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Miscellaneous Abbreviations: SAR= Sodium Adsorption Ratio, CEC= Cation Exchange Capacity, ESP= Exchangeable Sodium Percentage

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Soil Analysis Report
Canyon Fuel Company
Dugout Canyon Mine
P.O. Box 1029
Wellington, UT 84542

Report ID: S0805438001

Project: Dugout Canyon Mine
Date Received: 5/27/2008

Date Reported: 6/23/2008
Work Order: S0805438

Lab ID	Sample ID	TKN	Nitrogen Nitrate	Phosphorus	Boron	Selenium
		%	ppm	ppm	ppm	ppm
S0805438-001	WS Feb	0.27	0.21	<0.01	1.01	<0.02
S0805438-002	WS April	0.21	0.19	0.12	0.94	<0.02
S0805438-003	WS May	0.35	0.16	0.07	0.47	<0.02

These results apply only to the samples tested.

Abbreviations for extractants: PE= Saturated Paste Extract, H20Sol= water soluble,AB-DTPA= Ammonium Bicarbonate-DTPA, AAO= Acid Ammonium Oxalate
Abbreviations used in acid base accounting: T.S.= Total Sulfur, AB= Acid Base, ABP= Acid Base Potential, PyrS= Pyritic Sulfur, Pyr+Org= Pyritic Sulfur + Organic Sulfur, Neutral. Pot.= Neutralization Potential
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Soil Analysis Report

Canyon Fuel Company

Dugout Canyon Mine
P.O. Box 1029
Wellington, UT 84542

Report ID: S0805438001

Project: Dugout Canyon Mine
Date Received: 5/27/2008

Date Reported: 6/23/2008
Work Order: S0805438

Lab ID	Sample ID	Total Sulfur %	T.S. AB t/1000t	Neut. Pot. t/1000t	T.S. ABP t/1000t	Sulfate Sulfur %	Pyritic Sulfur %	Organic Sulfur %	PyriticS AB t/1000t	PyriticS ABP t/1000t	Total Carbon %
S0805438-001	WS Feb	0.88	27.4	60.9	33.6	0.08	0.57	0.23	17.7	43.2	15.8
S0805438-002	WS April	0.69	21.7	56.4	34.8	<0.01	0.49	0.19	15.4	41.0	15.5
S0805438-003	WS May	0.35	11.1	24.1	13.0	0.03	0.07	0.25	2.33	21.7	25.8

These results apply only to the samples tested.

Abbreviations for extractants: PE= Saturated Paste Extract, H20Sol= water soluble,AB-DTPA= Ammonium Bicarbonate-DTPA, AAO= Acid Ammonium Oxalate

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Reviewed by: Karen A Secor

Karen Secor, Soil Lab Supervisor

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Soil Analysis Report

Canyon Fuel Company

Dugout Canyon Mine
P.O. Box 1029
Wellington, UT 84542

Report ID: S0805438001

Project: Dugout Canyon Mine
Date Received: 5/27/2008

Date Reported: 6/23/2008
Work Order: S0805438

Lab ID	Sample ID	TOC %
S0805438-001	WS Feb	15.1
S0805438-002	WS April	14.9
S0805438-003	WS May	25.5

SEP 30 2008

These results apply only to the samples tested.

Abbreviations for extractants: PE= Saturated Paste Extract, H20Sol= water soluble,AB-DTPA= Ammonium Bicarbonate-DTPA, AAO= Acid Ammonium Oxalate
Abbreviations used in acid base accounting: T.S.= Total Sulfur, AB= Acid Base, ABP= Acid Base Potential, PyrS= Pyritic Sulfur, Pyr+Org= Pyritic Sulfur + Organic Sulfur, Neutral. Pot.= Neutralization Potential
Miscellaneous Abbreviations: SAR= Sodium Adsorption Ratio, CEC= Cation Exchange Capacity, ESP= Exchangeable Sodium Percentage

Reviewed by: Karen A Secor
Karen Secor, Soil Lab Supervisor

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Soil Analysis Report

Canyon Fuel Company

Dugout Canyon Mine
P.O. Box 1029
Wellington, UT 84542

Report ID: S0807229001

Project: Dugout Canyon Mine
Date Received: 7/10/2008

Date Reported: 8/18/2008
Work Order: S0807229

Lab ID	Sample ID	pH	Saturation	Electrical Conductivity	Field Capacity	Wilt Point	Calcium	Magnesium	Sodium	Potassium	SAR
		s.u.	%	dS/m	%	%	meq/L	meq/L	meq/L	meq/L	
S0807229-001	WS June	7.8	26.0	1.86	21	5.2	4.93	4.22	10.7	0.94	5.01
S0807229-002	WS July	7.9	24.9	1.39	19	6.5	2.29	2.40	9.04	0.78	5.91

SEP 30 2008

These results apply only to the samples tested.

Abbreviations for extractants: PE= Saturated Paste Extract, H20Sol= water soluble,AB-DTPA= Ammonium Bicarbonate-DTPA, AAO= Acid Ammonium Oxalate
Abbreviations used in acid base accounting: T.S.= Total Sulfur, AB= Acid Base, ABP= Acid Base Potential, PyrS= Pyritic Sulfur, Pyr+Org= Pyritic Sulfur + Organic Sulfur, Neutral. Pot.= Neutralization Potential
Miscellaneous Abbreviations: SAR= Sodium Adsorption Ratio, CEC= Cation Exchange Capacity, ESP= Exchangeable Sodium Percentage

Reviewed by: Karen A Secor
Karen Secor, Soil Lab Supervisor

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Soil Analysis Report

Canyon Fuel Company
Dugout Canyon Mine
P.O. Box 1029
Wellington, UT 84542

Report ID: S0807229001

Project: Dugout Canyon Mine
Date Received: 7/10/2008

Date Reported: 8/18/2008
Work Order: S0807229

Lab ID	Sample ID	Sand %	Silt %	Clay %	Texture	Available Sodium meq/100g	Exchangeable Sodium meq/100g
S0807229-001	WS June	76.0	16.0	8.0	Sandy Loam	0.62	0.34
S0807229-002	WS July	73.0	20.0	7.0	Sandy Loam	0.53	0.31

These results apply only to the samples tested.

Abbreviations for extractants: PE= Saturated Paste Extract, H20Sol= water soluble,AB-DTPA= Ammonium Bicarbonate-DTPA, AAO= Acid Ammonium Oxalate
Abbreviations used in acid base accounting: T.S.= Total Sulfur, AB= Acid Base, ABP= Acid Base Potential, PyrS= Pyritic Sulfur, Pyr+Org= Pyritic Sulfur + Organic Sulfur, Neutral. Pot.= Neutralization Potential
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Karen Secor, Soil Lab Supervisor

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Soil Analysis Report

Canyon Fuel Company
Dugout Canyon Mine
P.O. Box 1029
Wellington, UT 84542

Report ID: S0807229001

Project: Dugout Canyon Mine
Date Received: 7/10/2008

Date Reported: 8/18/2008
Work Order: S0807229

Lab ID	Sample ID	TKN	Nitrogen Nitrate	Phosphorus	Boron	Selenium
		%	ppm	ppm	ppm	ppm
S0807229-001	WS June	0.16	0.14	4.28	0.57	<0.02
S0807229-002	WS July	0.13	0.11	5.38	0.60	<0.02

SEP 3 0 2008

These results apply only to the samples tested.

Abbreviations for extractants: PE= Saturated Paste Extract, H20Sol= water soluble,AB-DTPA= Ammonium Bicarbonate-DTPA, AAO= Acid Ammonium Oxalate
Abbreviations used in acid base accounting: T.S.= Total Sulfur, AB= Acid Base, ABP= Acid Base Potential, PyrS= Pyritic Sulfur, Pyr+Org= Pyritic Sulfur + Organic Sulfur, Neutral. Pot.= Neutralization Potential
Miscellaneous Abbreviations: SAR= Sodium Adsorption Ratio, CEC= Cation Exchange Capacity, ESP= Exchangeable Sodium Percentage

Reviewed by: Karen A Secor
Karen Secor, Soil Lab Supervisor

Inter-Mountain Laboratories, Inc.
1673 Terra Avenue, Sheridan, Wyoming 82801
(307) 672-8945

Soil Analysis Report

Canyon Fuel Company
Dugout Canyon Mine
P.O. Box 1029
Wellington, UT 84542

Project: Dugout Canyon Mine
Date Received: 7/10/2008

Report ID: S0807229001
Date Reported: 8/18/2008
Work Order: S0807229

Lab ID	Sample ID	Total Sulfur	T.S. AB	Neutral. Potential	T.S. ABP	Sulfate Sulfur	Pyritic Sulfur	Organic Sulfur	PyriticS AB	PyriticS ABP	Total Carbon
		%	t/1000t	t/1000t	t/1000t	%	%	%	t/1000t	t/1000t	%
S0807229-001	WS June	0.61	19.0	84.2	65.2	0.01	0.45	0.14	14.2	70.0	9.9
S0807229-002	WS July	0.82	25.5	115	89.9	0.02	0.64	0.16	19.9	95.4	9.4

SEP 30 2008

These results apply only to the samples tested.

Abbreviations for extractants: PE= Saturated Paste Extract, H20Sol= water soluble,AB-DTPA= Ammonium Bicarbonate-DTPA, AAO= Acid Ammonium Oxalate
Abbreviations used in acid base accounting: T.S.= Total Sulfur, AB= Acid Base, ABP= Acid Base Potential, PyrS= Pyritic Sulfur, Pyr+Org= Pyritic Sulfur + Organic Sulfur, Neutral. Pot.= Neutralization Potential
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Soil Analysis Report

Canyon Fuel Company

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P.O. Box 1029
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Project: Dugout Canyon Mine
Date Received: 7/10/2008

Report ID: S0807229001
Date Reported: 8/18/2008
Work Order: S0807229

Lab ID	Sample ID	TOC %
S0807229-001	WS June	8.9
S0807229-002	WS July	8.0

These results apply only to the samples tested.

Abbreviations for extractants: PE= Saturated Paste Extract, H20Sol= water soluble,AB-DTPA= Ammonium Bicarbonate-DTPA, AAO= Acid Ammonium Oxalate
Abbreviations used in acid base accounting: T.S.= Total Sulfur, AB= Acid Base, ABP= Acid Base Potential, PyrS= Pyritic Sulfur, Pyr+Org= Pyritic Sulfur + Organic Sulfur, Neutral. Pot.= Neutralization Potential
Miscellaneous Abbreviations: SAR= Sodium Adsorption Ratio, CEC= Cation Exchange Capacity, ESP= Exchangeable Sodium Percentage

Reviewed by: Karen A Secor
Karen Secor, Soil Lab Supervisor

RA ATTACHMENT 5-5

AS-BUILT TOPOGRAPHY MAP

RA ATTACHMENT 5-6

REFUSE PILE ACCESS ROAD DRAWINGS

CHAPTER 6

GEOLOGY

CHAPTER 6

GEOLOGY

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CHAPTER 6
GEOLOGY

610 INTRODUCTION

This chapter presents a description of the geologic resources in the area of the Dugout Canyon Mine refuse pile area. Most of this chapter has been compiled from the approved Geology section of the Dugout Canyon Mine Mining and Reclamation Plan.

611 General Requirements

The geologic resources in the Dugout Canyon Mine refuse pile area are discussed in Sections 621 through 627 of this chapter.

612 Certification

A professional engineer has certified all maps, plans, and cross-sections, presented in this chapter, required by the regulations.

620 ENVIRONMENTAL DESCRIPTION

This section presents a description of the geologic resources in the area of the Dugout Canyon Mine refuse pile area.

621 General Requirements

This section presents the regional and site-specific geologic information for the Dugout Canyon Mine refuse pile area.

622 Cross Sections, Maps and Plans

A geologic map of the refuse pile area is provided as RA Figure 6-1. Because of the limited areal extent of the refuse pile area, cross sections have not been provided. The Mancos Shale underlies the storage area and the beds dip four to six degrees to the north. Quaternary age pediment gravels and alluvial fill cover the top of the mesas and fill drainages adjacent to the storage area.

623 Geologic Determinations

The information required by the Division to make a determination of the acid or toxic-forming characteristics of the site strata is presented in Section 624.300 of the approved M&RP.

The information required by the Division to make a determination as to whether the reclamation plan, described in Section 540, can be accomplished is presented in Section 624.

The information required to prepare the subsidence control program is addressed in Section 624.

624 Geologic Information

624.100 Regional Setting

The approved M&RP provides the bulk of the geologic information for this area. The description of the Cretaceous age Mancos Shale is specifically provided in the approved M&RP. In the refuse pile area the depth to bedrock varies from a few inches on the west to more than eight feet on the east. In this area, the Mancos Shale consists of marine shales with occasional interbeds of fine-grained sandstone. The beds are generally dipping to the north at four to six degrees with some local areas exhibiting dips greater than 10 degrees. The soils weathering from the shale generally contain elevated levels of sodium and exhibit low permeability.

Nearby ridge tops and mesas are covered with Quaternary-age pediment gravels that range in thickness of a few inches to more than 12 feet. The refuse pile area lies on top of a previously disturbed mesa.

Three boreholes were drilled to determine the depth to water. Based on the boreholes, the depth to ground water ranges from 35 to 90 feet below ground surface. These boreholes were completed as water level monitoring wells. RA Table 6-1 presents a summary of the completion details of the wells. RA Attachment 6-1 presents the lithologic logs and completion diagrams for the wells.

The refuse pile area will be located in an area of low permeability soils and shale bedrock thus significant recharge to a groundwater aquifer is not anticipated. No coal seams are present in the area and no mining currently exists or is planned. Runoff from the stockpile will be treated through the use of diversion ditches and a sediment pond. Therefore, no adverse impact on area surface or groundwater quality is anticipated.

624.200 Test Boring and Drill Hole Data (overburden removed)

No additional test borings or drill holes are planned for the site.

624.300 Test Boring and Drill Hole Data (overburden not removed)

No additional test borings or drill holes are planned for the site.

625 Additional Geologic Information

It is not anticipated that any additional geologic data will need to be collected for this site.

626 Sampling Waivers

A sampling waiver is not requested at this time for this site.

627 Description of the Overburden Thickness and Lithology

No mining will occur in this area. Therefore this regulation does not apply.

630 OPERATION PLAN

631 Casing and Sealing of Exploration Holes

No exploration holes exist in the area or are planned for the site.

632 Subsidence Monitoring

Subsidence will not occur in this area (see Section 525).

640 PERFORMANCE STANDARDS

641 Exploration and Drill Holes

No exploration holes exist in the area or are any planned for the site.

642 Monuments and Surface Markers of Subsidence Monitoring Points

No subsidence is currently planned for this area.

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REFERENCES

Anderson, P.B. 1978. Geology and coal resources of the Pine Canyon Quadrangle, Carbon County, Utah. Unpublished masters thesis. University of Utah, Salt Lake City, Utah.

U.S.G.S. 1972. Sunnyside Junction, Utah Quadrangle. Reston, Vi.

RA FIGURE6-1.DWG

FROM: USGS, 1972
Anderson, 1978

LEGEND

Qal	QUATERNARY ALLUVIUM
Qg	QUATERNARY PEDIMENT GRAVELS
Km	CRETACEOUS MANCOS SHALE

MAR 0 3 2003

0' 2500'

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RA FIGURE 6–1. AREA GEOLOGY

RA TABLE 6-1

OBSERVATION WELL COMPLETION SUMMARY[A]

Well Number	Total Drilled Depth (ft)	Elev. Top of Casing (ft)	Casing ID (in)	Length of Perf. (ft)	Formation Monitored
DH-1	45	5868.2	2.25	21	Mancos Shale
DH-2	70	5887.0	2.25	21	Mancos Shale
DH-3	120	5941.5	2.25	21	Mancos Shale

(a) See RA Plate 7-1 for well locations.

RA ATTACHMENT 6-1

BOREHOLE LOGS AND WELL COMPLETION DETAILS

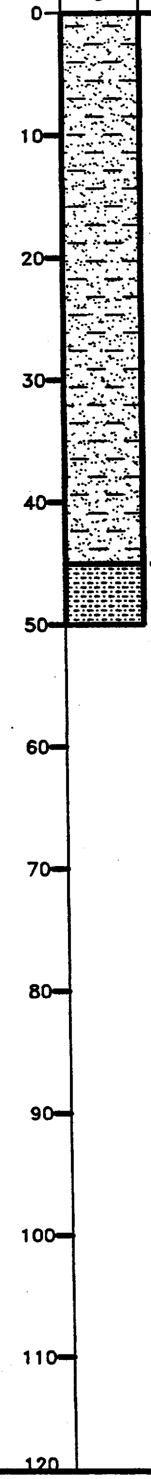
RA ATTACHMENT 6-1

BOREHOLE LOGS AND WELL COMPLETION DETAILS

CANYON FUEL COMPANY

Project Name: Refuse Pile Monitor Well Installation **Owner/Client:** Dugout Mine	**Boring/Well Number:** DH-1 **Boring/Well Location:** N 7769.83 E 9376.72
Project Number: UC-698-07	**Reference Elevation (ft):** **Reference Point:** Top of Casing
Date Drilled: October 1999 **Logged By:** JRP **Sample Method:** None	**Drilling Contractor:** Zimmerman Well Service **Rig Type:** SpeedStar **Drilling Method:** Air Rotary/Cable Tool
First Occurrence of G.W. (ft): 45 **Static W.L. (ft):** 36.35 **Date Measured:** December 2, 1999	**Boring Depth (ft):** 50 **Well Depth (ft):** 50 **Boring Diameter (in):** 7-7/8"

DEPTH (FT) | GRAPHICAL LOG



STRATIGRAPHIC DESCRIPTION AND OBSERVATIONS

0-45': Alluvium, lt. gray to lt. reddish brown silty sand, very fine to fine sand, with fine gravels. Dry. Loose.

Becoming more reddish brown.

Slight increase in gravel. Gravels ranged from fine to coarse, sub angular to subrounded.

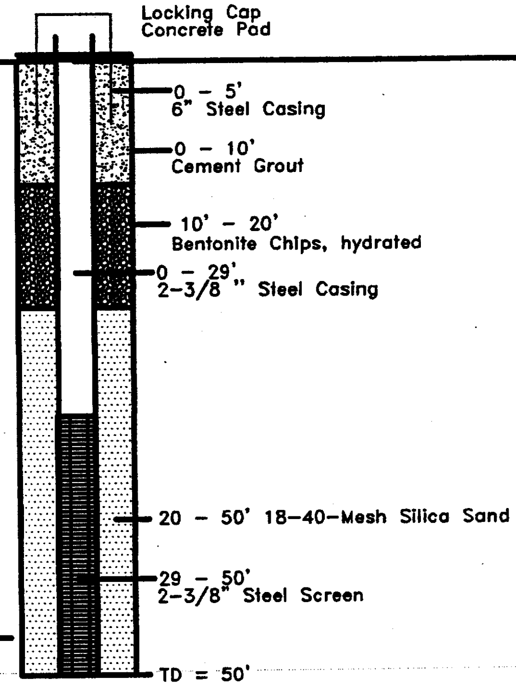
Decrease in amount of gravel. Mostly silty sand. pale reddish brown to lt grayish brown.

Increase in amount of gravel. Mostly fine to coarse gravel with some fine sand. Lt. gray.

36.35': Static water level, December 2, 1999.

45'-TD: Siltstone and Claystone, medium gray, thin bedded, fissle, damp. (Mancos Shale)

WELL COMPLETION DETAILS



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CANYON FUEL COMPANY

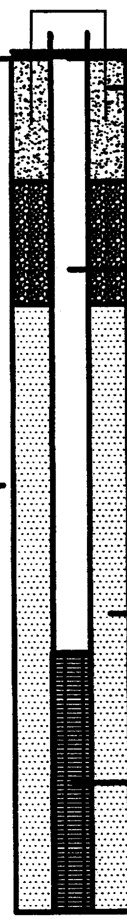
Project Name: Refuse Pile Monitor Well Installation **Owner/Client:** Dugout Mine	**Boring/Well Number:** DH-2 **Boring/Well Location:** N 7769.83 E 9376.72
Project Number: UC-698-07	**Reference Elevation (ft):** **Reference Point:** Top of Casing
Date Drilled: October 1999 **Logged By:** JRP **Sample Method:** None	**Drilling Contractor:** Zimmerman Well Service **Rig Type:** SpeedStar **Drilling Method:** Air Rotary/Cable Tool
First Occurrence of G.W. (ft): 35 **Static W.L. (ft):** 41.24 **Date Measured:** December 2, 1999	**Boring Depth (ft):** 70 **Well Depth (ft):** 70 **Boring Diameter (in):** 7-7/8"

STRATIGRAPHIC DESCRIPTION AND OBSERVATIONS

DEPTH (FT)	Description
0–10	0-35': Alluvium, silty sandy gravel, lt. brownish gray very fine to fine sand, with fine gravels. Dry. Loose.
20	Increase in gravels. Gravels ranged from fine to very coarse, with some cobbles.
	Decrease in fines.
30	Increase in fines.
35	35'-TD: Siltstone weathered, light to medium gray, thin bedded, brittle, wet. (Mancos Shale)
40	41.24': Static water level, December 2, 1999.
	Unweathered, medium to dark gray, damp.
50	Dark gray, wet.
60	Some very fine silty sandstone, wet.
	Some dark gray shale, decreasing sandstone, wet.
70	Increasing shale, no sandstone, wet.

Depth scale: 0, 10, 20, 30, 40, 50, 60, 70, 80, 90, 100, 110, 120

WELL COMPLETION DETAILS



Interval	Detail
	Locking Cap
	Concrete Pad
0 – 5'	6" Steel Casing
0 – 10'	Cement Grout
10' – 20'	Bentonite Chips, hydrated
0 – 49'	2-3/8 " Steel Casing
20 – 70'	18-40-Mesh Silica Sand
49 – 70'	2-3/8" Steel Screen
TD = 70'	

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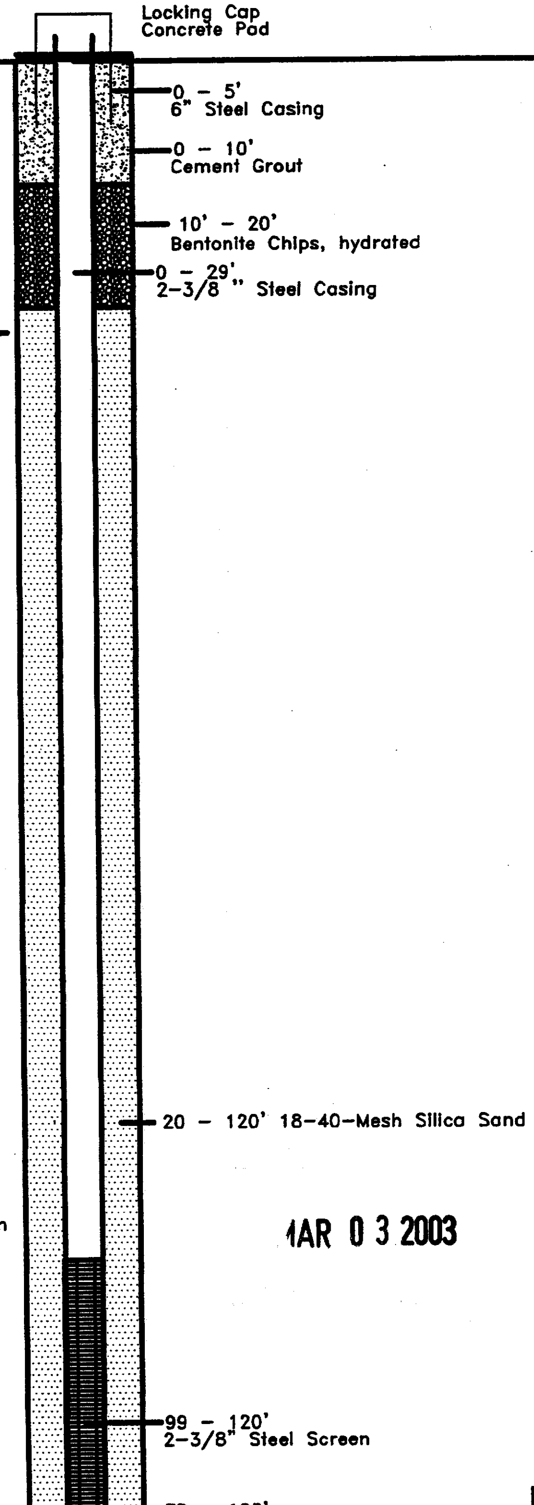
CANYON FUEL COMPANY

Project Name: Refuse Pile Monitor Well Installation Owner/Client: Dugout Mine	Boring/Well Number: DH-3 Boring/Well Location: N 7769.83 E 9376.72
Project Number: UC-698-07	Reference Elevation (ft): Reference Point: Top of Casing
Date Drilled: October 1999 Logged By: JRP Sample Method: None	Drilling Contractor: Zimmerman Well Service Rig Type: SpeedStar Drilling Method: Air Rotary/~~Cable Tool~~
First Occurrence of G.W. (ft): 20 Static W.L. (ft): 92.32 Date Measured: December 2, 1999	Boring Depth (ft): 120 Well Depth (ft): 120 Boring Diameter (in): 7-7/8"

DEPTH (FT)	GRAPHICAL LOG	STRATIGRAPHIC DESCRIPTION AND OBSERVATIONS
0		
10		0-20': Alluvium, sandy gravel, lt. brownish gray, very fine to medium sand, with some silt and fine to coarse gravels, clasts are rounded sandstone and siltstone. Damp. Loose.
20		20'-TD: Siltstone, light gray to lt brownish gray, thin bedded, brittle, wet. (Mancos Shale)
30		Unweathered, occassional shale fragments. Dark gray.
		Siltstone/Shale interbedded. Dark gray to brownish gray, fissle, wet.
40		
50		
60		Siltstone, dark gray, soft, occassional shale, wet.
70		
80		Slightly harder, less shale, wet.
90		92.32': Static water level, December 2, 1999.
		Siltstone/Shale interbedded. Thin bedded, dark brownish gray, soft to brittle, wet.
100		Siltstone. Dark gray to dark brownish gray, wet.
		Siltstone/Shale interbedded. Dark gray, brittle, wet.
110		Siltstone. Dark gray, very thin bedded, brittle, wet.
120		

WELL COMPLETION DETAILS



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CHAPTER 7

HYDROLOGY

710 INTRODUCTION

711 General Requirements

This chapter presents a description of:

Proposed operations and the potential impacts to the hydrologic balance;

Methods of compliance with design criteria and the calculations utilized to show compliance; and

Applicable hydrologic performance standards.

712 Certification

A qualified, registered professional engineer has certified all maps, plans, and cross sections presented in this chapter.

713 Inspection

Refer to the approved M&RP

720 ENVIRONMENTAL DESCRIPTION

721 General Requirements

This section presents a description of the pre-mining hydrologic resources within the permit and adjacent areas that may be affected or impacted by the proposed coal mining and reclamation operation.

Reference RA Attachment 2-3 for soil information, pictures and drawings and RA Attachment 7-3, Addendum A for hydrologic information pertaining to the soil borrow area to be used for reclamation of the refuse pile.

722 Cross Sections and Maps

722.100 Location and Extent of Subsurface Water

No seeps or springs are present in the immediate area of the refuse pile site. Three monitoring wells were installed in the site area (see RA Plate 7-1). The completion details of these wells are discussed in Chapter 6, RA Attachment 6-1of this submittal.

722.200 Location of Surface Water Bodies

Dugout Creek is located to the east of the refuse pile between an 1/8 and 1/4 of a mile. Due to the distance to the creek, no impact to this stream is anticipated.

722.300 Locations of Monitoring Stations

Two surface water monitoring stations have been located for the refuse pile area (see RA Plate 7-1). These stations are discussed in Section 731 of this submittal.

722.400 Location and Depth of Water Wells

No water-supply wells exist in the refuse pile area.

722.500 Surface Topography

Surface topographic features in the permit and adjacent areas are shown on the base map used for RA Plate 7-1.

723 Sampling and Analysis

Refer to the approved M&RP.

724 Baseline Information

Baseline information for Dugout Creek is presented in the approved M&RP. Baseline data for the sampling of the groundwater and surface water stations are presented in RA Attachment 7-1.

724.100 Groundwater Information

<u>Mancos Shale.</u> The refuse pile area is located on the Mancos Shale. The relatively impermeable marine shale is not considered to be a regional or local aquifer. Groundwater samples collected from four monitoring wells (MW-1M, MW-2M, MW-3M and MW-1C) located approximately 2 miles south of Soldier Canyon Mine (see Plate 7-1, RA Attachment 7-6) have a mean TDS concentration of approximately 10,000 mg/l and are of the sodium-sulfate-chloride type (Appendix 7-3 of the approved M&RP). Chemical compositions are consistent with the dissolution of halite and gypsum as well as cation exchange. While it is anticipated that the water quality within the Mancos Shale in the Soldier Canyon Mine area is similar to the waste rock site, samples will be obtained from DH-

1 beginning in the first quarter of 2003. Water samples from this drill hole will be analyzed for the parameters listed in Table 7-4 of the existing M&P.

Recharge and Discharge Relations. Recharge to the Mancos Shale within the refuse pile area would be minimal since the formation is relatively impermeable, the refuse pile area is limited to only a few acres, and the refuse pile area is not located within a known recharge area.

Depth to Groundwater. Water level measurements from the three monitoring wells located on or immediately adjacent to the refuse pile site indicate that water is found at a depth ranging from 35 to 90 feet below ground surface. The water is originating either from the Mancos Shale or from the Alluvium/ Mancos Shale contact. It took approximately one month for the water levels in the wells to stabilize, indicating a very low permeability for the formation. The direction of groundwater flow is to south toward Dugout Creek (see RA Figure 7-1).

724.200 Surface Water Information

The refuse pile area exists entirely within the Dugout Creek watershed. Based on field observations, Dugout Creek is considered to be intermittent in this area. Several smaller tributaries to the creek in the area are ephemeral. No gauging stations are located within the immediate area of the refuse pile. The disturbance associated with the construction of the refuse pile is not anticipated to significantly increase or decrease runoff to Dugout Creek (Appendix 7-9, Addendum A).

Two baseline surface water monitoring stations have been located in the ephemeral drainage to the southwest of the refuse pile. Data from these stations is presented in RA Attachment 7-1. No flow has been identified in the drainage through during the period of monitoring (August 2002).

724.300 Geologic Information

Geologic information related to the refuse pile area and adjacent areas is presented in Chapter 6 of this submittal and the approved M&RP.

724.400 Climatological Information

Climatological data are summarized in Appendix 4-1 of the approved M&RP and in RA Attachment 7-5.

724.500 Supplemental Information

All information pertinent to a determination of the probable hydrologic consequences of the constructing, maintaining, and reclaiming of the proposed refuse pile are presented in both this submittal and the approved M&RP.

724.600 Survey of Renewable Resource Lands

The existence and recharge of groundwater systems in the refuse pile and adjacent areas is discussed in Section 724.100 of this submittal and the approved M&RP.

724.700 Alluvial Valley Floor Requirements

Information regarding the presence or absence of alluvial valley floors in the permit and adjacent areas is presented in Chapter 9 of the approved M&RP and this submittal.

725 Baseline Cumulative Impact Area Information

The hydrologic and geologic information required for the Division to develop a Cumulative Hydrologic Impact Assessment is presented in the approved M&RP and this submittal under Chapters 6 and 7. Required information not available in these chapters is available from the Utah Divisions of Water Rights and Water Resources and from the U.S. Geological Survey and the U.S. Bureau of Land Management.

726 Modeling

No numerical groundwater or surface water modeling was conducted in support of this submittal.

727 Alternative Water Source Information

No surface mining will be conducted in this area and adjacent areas. Therefore, this section does not apply.

728 Probable Hydrologic Consequences

This section addresses the probable hydrologic consequences of construction and reclamation operations in the refuse pile area. Mitigating measures are discussed generally in this section and in detail in Section 730 of the approved M&RP.

728.100 Potential Impacts to Surface and Groundwater

Potential impacts of storing refuse and materials in this area on the quality and quantity of surface and groundwater flow may include:

Contamination from acid- or toxic- forming materials;
Increased sediment yield from disturbed areas;

Increased total dissolved solids concentrations;
Impacts to groundwater or surface water availability;
Hydrocarbon contamination from the use of hydrocarbons in the refuse pile area; and
Contamination of surface and groundwater from road salting activities.

These potential impacts are addressed in the following sections and in the approved M&RP.

728.200 Baseline Hydrologic and Geologic Information

Baseline geologic information is presented in Chapter 6 of the approved M&RP and this submittal. Baseline hydrologic information is presented in Sections 724.100 and 724.200 of the approved M&RP.

728.300 PHC Determination

Potential Impacts to the Hydrologic Balance. Potential impacts of the Dugout Canyon Mine on the hydrologic balance of the refuse pile and adjacent areas are addressed in the following subsections of this submittal and the approved M&RP.

Acid- or Toxic- Forming Materials. No acid- or toxic-forming materials have been identified in the soils or strata of the Dugout Canyon Mine (Chapter 6 of the approved M&RP). Canyon Fuel commits to sampling any refuse materials generated by the mine in accordance with the approved M&RP to aid in identifying any acid- or toxic-forming materials. Thus, no significant potential exists for the contamination of surface and groundwater in the refuse pile and adjacent areas by acid- or toxic-forming materials. In the event that acid- or toxic-forming materials are identified, this material will be buried with a minimum of 4 feet of non-acid, non-toxic, non-combustible materials.

Sediment Yield. The potential impact of construction, maintenance, and reclamation of the refuse pile on sediment yield is an increase in sediment in the surface waters downstream from disturbed areas. Sediment-control measures (such as diversions, sediment pond, straw bales, etc.) will be installed to minimize this impact. These facilities will be regularly inspected (see Section 514 of the M&RP) and maintained to ensure that they remain in proper operating condition.

Various sediment-control measures will be implemented during reclamation as the vegetation becomes established. As discussed in Section 542.200 of this submittal, these measures will include maintenance of sediment pond, berms, and diversions in appropriate locations to minimize potential contributions of sediment to Dugout Creek and off-site areas. These measures will reduce the amount of erosion from the reclaimed areas, thereby precluding adverse impacts to the environment.

Once vegetation is adequately established, the berms will be pushed into the diversion ditches and revegetated in accordance with Chapter 2 and 3 of this submittal. Additionally, the sediment pond embankment will be breached and the outlet works of the sediment pond will be removed, thereby ensuring a positive drainage from the site area.

Acidity, Total Suspended Solids, and Total Dissolved Solids. Probable impacts of mining and reclamation operations on the acidity and total suspended solids concentrations of surface and groundwater in the permit and adjacent areas were addressed previously in this section.

Groundwater and Surface Water Availability. Construction, maintenance, and reclamation of the refuse pile will not affect groundwater and surface water availability. As discussed previously, the refuse pile is of limited areal extent, is located on the Mancos Shale, and does not significantly affect surface runoff.

Potential Hydrocarbon Contamination. Diesel fuel, oils, greases, and other hydrocarbon products will not be stored at the site. Fuels, greases and other oils may leak from equipment during construction operations. These spills will be handled as specified in the approved M&RP.

Road Salting. No salting of roads will occur within the refuse pile area. Hence, this impact is not a significant concern.

729 Cumulative Hydrologic Impact Assessment (CHIA)

A Cumulative Hydrologic Impact Assessment to include the permit and adjacent areas is to be prepared by the Division.

730 OPERATION PLAN

731 General Requirements

731.100 Hydrologic-Balance Protection

Groundwater Protection. The affect on groundwater in this area is expected to be minimal as discussed in Section 724.200. Groundwater will not be encountered or used during construction, maintenance, and reclamation of the refuse pile. The three wells that have been drilled in this area are used to aid in monitoring the potential impacts of the refuse pile.

Surface Water Protection. To protect the hydrologic balance, construction, maintenance, and reclamation operations will be conducted to handle earth materials and runoff in a manner that prevents, to the extent possible, additional contributions of suspended solids to streamflow outside the permit area, and otherwise prevents water pollution. Additionally, CFC will maintain adequate runoff- and sediment-control facilities to protect local surface waters.

During initial construction and prior to installation of all runoff- and sediment-control facilities, silt fences were installed along the down gradient edge of the refuse pile area. These silt fences were installed in accordance with the approved M&RP. If required for control of local erosion, straw-bale dikes may also be installed at the site during initial construction. The silt fences and straw-bale dikes will be periodically inspected, and accumulated sediment will be removed as needed to maintain functionality. Once the diversion ditches are installed, the silt fences and straw-bale dikes will be removed.

The initial placement of waste rock will take place in an area lower than the existing surrounding grade. The operator will construct the appropriate ditches adjacent to and upstream of the growing pile once the surface of the pile meets and exceeds the level of the surrounding existing ground surface. Prior to construction of the ditches, a temporary interim berm will be constructed upstream of the below-grade storage area to divert water to the sediment pond (RA Plate 7-1)

Once the runoff- and sediment-control facilities outlined in Section 732 have been installed, these structures will prevent additional contributions of suspended solids to streamflow outside the permit area. A description of sediment control following reclamation is presented in Sections 540 and 760 of this submittal and the approved M&RP.

Reference RA Attachment 7-3, Addendum A for hydrologic information pertaining to the soil borrow area.

731.200 Water Monitoring

Groundwater Monitoring. Groundwater monitoring associated with the refuse pile will include quarterly water level measurements. In accordance with Table 7-4, Groundwater Monitoring Program of the approved M&RP, Wells DH-1, DH-2 and DH-3 will be monitored using Protocols A, 1. Water quality samples will be obtained quarterly from DH-1 beginning in the first quarter of 2003 and ending the 4^{th} quarter of 2004. Thereafter, a water quality sample from DH-1 will be taken annually, until bond release. The samples from DH-1 will be analyzed for the parameters listed in Table 7-4, "Groundwater Monitoring Program". At least one borehole volume of water will be removed from the well prior to obtaining the water sample for analysis. Water level data collected through the first quarter of 2002 are presented in RA Attachment 7-1.

Should the subsoil stockpile be moved to the area of Well DH-2, the casing will be elevated above the stockpile to allow for continued monitoring (RA Plate 7-1).

Surface Water Monitoring. Two surface water monitoring sites are located in the refuse pile area (see RA Plate 7-1). These stations are located on the ephemeral drainage to the west and southwest of the pile. One point is located upstream of the pile, while the second point is located downstream of the site at the county road crossing. These stations are monitored to evaluate surface-water conditions upstream and downstream from the pile. The stations will be monitored in accordance with the schedule and protocols established in the approved M&RP. In accordance with Table 7-5, Surface Water Monitoring Program of the approved M&RP, Surface Water Monitoring Sites SS-1 and SS-2 are monitored using Protocol 1. Data collected through the third quarter of 2002 are presented in RA Attachment 7-1.

731.300 Acid- and Toxic-Forming Materials

Acid- or toxic forming materials are not expected to be produced from the mine. CFC commits to monitor all materials produced and analyze them for acid- or toxic-forming materials. If any materials are identified, they will be placed in the refuse pile and covered with a minimum of 4 feet of non-acid, non-toxic, non-combustible materials. Copies of the toxicity/acid-base results from the samples collected at the Dugout Canyon Mine are presented in RA Attachment 5-4 and Appendix 5-7 of the approved M&RP.

731.400 Transfer of Wells

The three ground water monitoring wells, which exist at the site, will be abandoned following the reclamation of the site when no longer required for ground water monitoring. Therefore, no well transfers are required.

731.500 Discharges

No mines are located in the refuse pile area, thus no discharges to mines is possible.

731.600 Stream Buffer Zones

The refuse pile for the Dugout Canyon Mine will not be constructed within 100 feet of a perennial stream.

Stream Channel Diversions. No stream channel diversions are planned for this site.

Buffer Zone Designation. No buffer zone designation is necessary at this site.

731.700 Cross Sections and Maps

RA Plate 7-1 shows the location of each monitoring station and the watershed boundaries for the area watersheds. RA Plate 7-1 shows the proposed location of the diversion ditches and culverts and sediment pond associated with the refuse pile area. RA Plate 7-2 presents the design details of the sediment pond with appropriate cross sections of the pond and embankment.

731.800 Water Rights and Replacement

No surface or groundwater sources are located within the refuse pile area.

732 Sediment Control Measures

The sediment control measures within the refuse pile area have been designed to prevent additional contributions of sediment to stream flow or to runoff outside the permit area. In addition, they have been designed to meet applicable effluent limitations, and minimize erosion to the extent possible.

The structures to be used for the runoff-control plan for the permit area include disturbed and undisturbed area diversion channels, a sedimentation pond, berms, silt fences, and road diversions and culverts.

Reference RA Attachment 7-3, Addendum A for hydrologic information pertaining to the soil borrow area.

732.100 Siltation Structures

The siltation structure within the permit area is a sediment pond as described in Section 732.200. In addition to the sediment pond, a berm encircles the topsoil/subsoil stockpiles, providing treatment and total containment of the runoff from the stockpiles (RA Attachment 7-3). Typical cross sections of the ditches, berm and containment area are located in RA Attachment 7-4.

732.200 Sedimentation Ponds

There is a single sedimentation pond operating at the refuse pile site. The sedimentation pond topography and cross sections are presented on RA Plate 7-2 of this submittal. Details regarding sedimentation pond design are presented in Section 742.100 and RA Attachment 7-2. The sedimentation pond is defined as a Class A pond in accordance with TR-60 (U.S. Soil Conservation Service, 1976). A clean-out marker will be installed in the sediment pond.

The sedimentation pond is within the disturbed area boundary and is subject to final reclamation. The area is included in the calculation of the disturbed area subject to bonding and in the calculation of final reclamation costs.

Compliance Requirements. The sedimentation pond will be maintained until removal in accordance with the reclamation plan (see Section 540 of this submittal). When the pond is removed, the land will be revegetated in accordance with the reclamation plan defined in Section 540.

MSHA Requirements. MSHA requirements defined in 30 CFR 77.216 are not applicable since the sedimentation pond will not impound water or sediment to an elevation of 20 feet or more above the upstream toe of the structure. The pond will have a storage volume of less than 20 acre-feet.

732.300 Diversions

The objective of the runoff control plan is to isolate, to the maximum degree possible, runoff from disturbed areas from that of undisturbed areas. This is accomplished by routing runoff from the undisturbed slope above the refuse pile facilities via diversion berm/ditch UD-2 around the upstream side of the pile (see RA Plate 7-1). Disturbed area runoff will be collected by five diversion ditches and conveyed to the sediment pond. A brief list of each proposed diversion structure is as follows:

Diversion Ditches:

Undisturbed drainage ditches UD-1a,b and c located on the north side of the pile, will collect runoff from the undisturbed watershed above of the pile. The runoff will be discharge into UC-1.

Disturbed drainage ditch DD-1 is located along the east side of the pile.
Disturbed drainage ditches DD-2a and b are located on the west side of the pile.
Disturbed drainage ditches DD-3a and b will connect ditches DD-1 and DD-2 to the sediment pond.

Diversion Culverts:

Culvert UC-1 will convey runoff from the county road borrow ditch under the pile access road. This runoff will ultimately discharge to the natural drainage under the county road.

Culvert UC-2 will be constructed only if the "topsoil stockpile" is relocated adjacent to the Dugout Canyon Road. UC-2 will convey water from the undisturbed drainage above the disturbed area, under the stockpile to the undisturbed drainage below the site (RA Table 7-4 and RA Attachment 7-4). Detailed diversion design is presented in Section 742.

732.400 Road Drainage

No permanent roads are to be built within the refuse pile area. Road drainage facilities will include diversion ditches and culverts. The road drainage diversion ditches and culverts for the refuse pile area are included in the list of diversions presented in Section 732.300 above. Additional road drainage design information is presented in Section 742.

All road drainage diversions will be maintained and repaired as needed. The culvert to be installed in the county road borrow ditch within the disturbed area is discussed in Section 742.300.

733 Impoundments

733.100 General Plans

There is a single sedimentation pond operating at the refuse pile facility as described in Section 732.200. The sedimentation pond is located in the southern portion of the disturbed area. The sedimentation pond topography and cross sections are presented on RA Plate 7-2 of this submittal. Detailed design information is presented in RA Attachment 7-2.

Certification. All maps and cross sections of the sedimentation pond have been prepared by or under the direction of, and certified by a qualified, registered, professional engineer.

Maps and Cross Sections. The topography and cross sections for the sedimentation pond are provided on RA Plate 7-2 of this submittal.

Narrative. A description of the sedimentation pond is presented in Sections 732.200 and 742 of this submittal.

Subsidence Survey Results. No underground coal mining will occur beneath the proposed sedimentation pond. Therefore, there will be no effects on the pond or pond embankment from subsidence.

Hydrologic Impact. The hydrologic and geologic information required to assess the hydrologic impacts of the proposed sedimentation pond are presented in Section 724 and Chapter 6 of this submittal and approved M&RP, respectively.

Design Plans and Construction Schedule. There are no additional structures proposed for the refuse pile area at this time. Any structures proposed in the future will not be constructed until the Division has approved the detailed design plan for the structure.

733.200 Permanent and Temporary Impoundments

Requirements. The sedimentation pond has been designed using current, prudent engineering practices. Specific foundation design and construction criteria are presented in Chapter 5 of this submittal. Specific hydrologic design criteria for the pond are presented in Section 743. The pond will be inspected regularly based on the schedule contained in Section 514.300.

Permanent Impoundments. There are no permanent impoundment structures proposed for use in mining and reclamation operations within the permit and adjacent areas.

Temporary Impoundments. The Division's authorization is being sought for the construction of the sedimentation pond as a temporary impoundment at the refuse pile area as part of coal mining and reclamation operations.

Hazard Notifications. The sedimentation pond will be examined for structural weakness and erosion in accordance with the schedule presented in Section 514.300. A report of these findings will be submitted to the Division as outlined in Section 514.300.

734 Discharge Structures

Discharge structures within the refuse pile area will consist of the emergency spillway on the sedimentation pond. All discharge structures will be constructed and maintained to comply with R645-301-744.

Reference RA Attachment 7-3, Addendum A for hydrologic information pertaining to the soil borrow area.

735 Disposal of Excess Spoil

There will be no excess spoil generated in the refuse pile area.

736 Coal Mine Waste

Coal mine waste generated by the Dugout Mine, will be stored and disposed of as described in Chapter 5 of this submittal.

737 Noncoal Mine Waste

Noncoal mine waste will be stored and disposed of as described in Chapter 5 of the approved M&RP.

738 Temporary Casing and Sealing of Wells

Each groundwater monitoring well identified on RA Plate 7-1 will be operated and maintained as described in Section 748.

740 DESIGN CRITERIA AND PLANS

741 General Requirements

This submittal includes site-specific plans that incorporate minimum design criteria for the control of drainage from disturbed and undisturbed areas.

742 Sediment Control Measures

742.100 General Requirements

Design. Sediment-control measures have been designed to provide the following:

Prevent additional contributions of sediment to stream flow or to runoff outside the permit area;

Meet the effluent limitations defined in Section 751 of this amendment; and

Minimize erosion to the extent possible.

Measures and Methods. The sediment control measures at the mine will include practices carried out within and adjacent to the disturbed area. Sediment control methods will include:

Retention of sediment within the disturbed area;

Diversion of upstream runoff away from the disturbed area; and

Provision of silt fences, riprap, contemporaneous revegetation, vegetative sediment filters, a sediment pond, and other measures that reduce overland flow velocities, reduce runoff volumes or trap sediment.

742.200 Siltation Structures

General Requirements. Additional contributions of suspended solids and sediment to stream flow or runoff outside the permit area will be prevented to the extent possible using a sedimentation pond. The pond will be constructed before refuse pile construction operations begin. A qualified registered professional engineer will certify pond construction.

Sedimentation Ponds. A single sedimentation pond has been designed for the refuse pile facilities. The sedimentation pond is located in the southern portion of the disturbed area. This pond will function as a single total containment pond with no planned discharge. (i.e. it's freakin huge)

The location of the sedimentation pond is shown on RA Plate 7-1. The pond will not be located within a perennial stream channel.

Design, Construction, and Maintenance

The entire area draining to the sedimentation pond has been defined as a single watershed (DWS-1). The sedimentation pond has been designed to control sediment from areas which have been disturbed. The disturbed area contributing runoff to the sedimentation pond contains 15.60 acres. Refer to RA Plate 7-1 for a delineation of watershed boundaries and RA Attachment 7-2 for additional pond detail.

The sedimentation pond was designed to fully contain the sediment generated within the disturbed area. The sedimentation pond has been designed with a sediment storage capacity of 0.67 feet. The elevation of the maximum sediment level is 5897.55 feet. The 60% sediment clean-out volume of 0.40 acre-feet is an elevation of 5896.5 feet.

Sediment Removal. Sediment removal from the sedimentation pond will occur when the sediment level reaches the 60% clean-out level. The sediment will be disposed in the refuse pile as discussed in Section 526.100 and 732.200 of this M&RP.

Design Event. As this is a total containment structure, the sedimentation pond has been designed to fully contain runoff resulting from the 100-year, 24-hour precipitation event (2.8 inches), instead of the 10-year, 24-hour event (1.65inches). This will provide a significant additional storage volume.

Detention Time. As this structure is planned to be a total containment pond, no decant structure will be part of the pond design. If collected water is to be removed from the structure, Division approval will be obtained and an adequate detention time will be provided in the water collected in the pond to allow the effluent to meet UPDES and 40 CFR Part 434 limitations.

Runoff Volume. The curve numbers used to determine the runoff volumes were based on professional judgment and soil and vegetation information presented in Chapters 2 and 3 of this submittal. The curve number for the pond area was assumed to be 90.

The storm runoff volume to the sedimentation pond resulting from the 100-year, 24-hour storm event was calculated to be 2.22 acre-feet. The combined volume of the runoff from the 100-year, 24-hour storm event and the maximum sediment storage is 2.89 ac-ft. Calculations for pond sizing are contained in RA Attachment 7-2.

As the pond is a total containment structure, no principal spillway or dewatering structure is included in the design. RA Attachment 7-2 presents the stage-capacity table for the pond.

An open-channel emergency spillway has been designed for the pond to allow discharge from the pond in the event that a series of greater than design events occur within a short period. Details regarding this emergency spillway are discussed in RA Attachment 7-2.

The emergency spillway has been designed with a median riprap diameter of 6 inches within the crest section and 12 and 9 inches in the outslope sections of the spillway. This riprap was underlain with a geofabric liner. The expected velocity at the spillway outlet to the ephemeral channel will be 4.47 feet per second, which velocity is not considered erosive. Calculations regarding the emergency spillway are presented in RA Attachment 7-2.

Dewatering Device. No dewatering device is planned for the pond. Runoff water collected will seep through the pond bottom, evaporate from the ponded water surface, and be used for dust suppression on the site area.

Short Circuiting. Short circuiting will not occur as the pond will be a total containment structure.

<u>Excessive Settlement.</u> The sedimentation pond is to be incised in native material. Therefore, it is not expected that embankment settlement will be a significant concern. Stability analyses presented in Chapter 5 indicate that the pond embankment will be stable under both normal and rapid drawdown conditions.

<u>Embankment Material.</u> During construction of the sedimentation pond, the inslope of the pond was shaped to provide a 2H:1V slope. Material to be used on the inslope was inspected to ensure the material is free of sod, large roots, and frozen soil.

<u>Compaction.</u> The sedimentation pond was incised in native materials. Any materials that are disturbed during the inslope reshaping will be compacted to a minimum dry density of 90% as determined by ASTM D1557.

<u>MSHA Sedimentation Ponds.</u> MSHA requirements defined in 30 CFR 77.216 are not applicable at this site since the proposed sedimentation pond will not impound water or sediment to an elevation of 20 feet or more above the upstream toe of the structure. The pond will also store a volume less than 20 acre-feet.

Other Treatment Facilities. There are no other treatment facilities within the mine permit area.

Exemptions. No exemptions are being proposed at this time.

742.300 Diversions

General Requirements. The diversions within the refuse pile area will consist of drainage ditches and culverts. All diversions within the site area have been designed to minimize adverse impacts to the hydrologic balance, to prevent material damage outside the permit area, and to assure the safety of the public.

All diversions and diversion structures have been designed and will be constructed, maintained and used to:

Be stable;

Provide protection against flooding and resultant damage to life and property;

Prevent, to the extent possible, additional contributions of suspended solids to stream flow outside the permit area; and

Comply with all applicable local, state, and federal laws and regulations.

All diversions within the refuse pile area will be removed when no longer needed. The diversions will be reclaimed in accordance with the reclamation plan defined in Chapter 5.

Peak discharge rates from the undisturbed and disturbed area drainages within the site area were calculated for use in designing diversion ditches and culverts. The storm runoff calculations for the temporary diversion structures were based on the 100-year, 6-hour precipitation event of 2.05 inches.

Curve numbers were based on professional judgment and information presented in Chapters 2 and 3 of this submittal. The curve numbers for the various watersheds are summarized in RA Attachment 7-4.

The drainage areas within and above the facilities area are presented on RA Plate 7-1. A summary of the characteristics of watersheds contributing to the diversions is presented in RA Attachment 7-4.

The size and location of each proposed diversion ditch and culvert will be verified in the field prior to initiating refuse pile construction. All proposed diversions are presented on RA Plate 7-1. The minimum capacity and freeboard of each diversion ditch and culvert was determined based on the minimum ditch slope. The maximum velocity and need for a channel lining or outlet protection was calculated based on the maximum ditch or culvert slope. Slopes were measured from a contour map with a scale of 1" = 100'. All diversion and culvert calculations are presented in RA Attachment 7-4 and summarized in RA Tables 7-3 and 7-4.

Diversion Berms. Diversion ditch DD-1 planned for this site will be an asymetrical ditch which will have a 10H:1V slope from the pile to the ditch bottom and a 2H:1V slope out of the ditch. The purpose of this ditch shape is to provide vehicle access to the pile outslope once the final configuration is reached, as well as a means of conveying the runoff from the pile. However, to meet MSHA requirements for safety concerns adjacent to slopes, a berm will need to be placed immediately adjacent to the ditch along the outslope. Since none of the berms have been designed specifically to convey runoff, no calculations concerning the hydraulic characteristics of these berms are provided.

An temporary interim berm will be constructed to divert water away from the below grade waste rock storage area. This will remain in place until the waste rock fill reaches the level of the surrounding ground and the construction of Ditches DD-1 and DD-2 is completed.

742.400 Road Drainage

No permanent roads are to be built in the refuse pile area. Runoff from the temporarily constructed road within the disturbed area will be treated by collection in the diversion ditches and sediment pond. The drainage ditches associated with the county road will be maintained during operations by placing a culvert under the refuse pile access road. Once the refuse pile is completed and reclaimed so that the road is no longer required for access, the drainage ditch along the county road will be restored by removing the culvert and reclaiming the road in accordance with Chapter 5 of this submittal. None of these roads are located in the channel of an intermittent or perennial stream. Control structures have been located to minimize downstream sedimentation and flooding. Diversion ditches and culverts for all roads are described in Section 732.300.

743 Impoundments

All pertinent information regarding the sedimentation pond is presented in Sections 732.200 and 742.200.

744 Discharge Structures

The discharge structure within the permit area is the emergency spillway on the sedimentation pond. The spillway on the sedimentation pond has been designed to pass the 100-year, 6-hour storm event assuming that the pond was full. Therefore, the spillway will adequately pass the peak discharge from the 25-year, 6-hour precipitation event. Detailed information concerning the sedimentation pond is presented in Section 742.200.

745 Disposal of Excess Spoil

There will be no excess spoil generated within the refuse pile area.

746 Coal Mine Waste

746.100 General Requirements

All coal mine waste will be placed in a controlled manner to minimize adverse effects of leachate and surface water runoff on surface and groundwater quality and quantity. This waste will be placed in the refuse pile facility as described in Chapter 5 of this submittal.

746.200 Refuse Piles

A detailed description of the refuse pile is presented in Chapter 5 of this submittal.

746.300 Impounding Structures

No impounding structures within the refuse pile area will be constructed of coal mine waste or used to impound coal mine waste.

746.400 Return of Coal Processing Waste to Abandoned Underground Workings

No coal processing waste will be generated in the permit area.

747 Disposal of Noncoal Mine Waste

Disposal of noncoal mine waste is discussed in Chapter 5 of the approved M&RP.

748 Casing and Sealing of Wells

Each monitoring well has been cased, sealed, or otherwise managed, as approved by the Division, to prevent acid or other toxic drainage from entering ground or surface water, to minimize disturbance to the hydrologic balance, and to ensure the safety of people, livestock, fish and wildlife, and machinery in the site and adjacent area. The drill logs and completion diagrams for the wells are contained in RA Attachment 6-1.

750 PERFORMANCE STANDARDS

All operations will be conducted to minimize disturbance to the hydrologic balance within the permit and adjacent areas, to prevent material damage to the hydrologic balance outside the permit area, and support approved post-mining land uses.

751 Water Quality Standards and Effluent Limitations

Discharges of water from disturbed areas will be in compliance with all Utah and federal water quality laws and regulations and with effluent limitations for coal mining contained in 40 CFR Part 434.

752 Sediment Control Measures

All sediment control measures will be located, maintained, constructed and reclaimed according to plans and designs presented in Sections 732, 742, and 760 of this submittal and the approved M&RP.

752.100 Siltation Structures and Diversions

Siltation structures and diversions will be located, maintained, constructed and reclaimed according to plans and designs presented in Sections 732, 742, and 763 of this submittal and the approved M&RP.

752.200 Road Drainage

Runoff from temporary roads will be treated through siltation structures which will be located, maintained, constructed and reclaimed according to plans and designs presented in Sections 732, 742, and 763 of this submittal and the approved M&RP.

753 Impoundments and Discharge Structures

Impoundments and discharge structures will be located, maintained, constructed and reclaimed as described in Sections 733, 734, 743, 745, and 760 of this M&RP.

754 Disposal of Excess Spoil, Coal Mine Waste and Noncoal Mine Waste

Disposal areas for coal mine waste and noncoal mine waste will be located, maintained, constructed and reclaimed as described in Sections 736, 737, 746, 747, 760 and Chapter 5 of this submittal and the approved M&RP.

755 Casing and Sealing of Wells

All wells will be managed as described in Sections 551, 748 and 765 of this submittal.

760 RECLAMATION

761 General Requirements

A detailed reclamation plan for the mine is presented in Section 540. In general, CFC will ensure that all temporary structures are removed and reclaimed. Other than for restoration of natural drainage patterns, no permanent diversions are included in the reclamation plan. Reference RA Attachment 2-3 for soil information, pictures and drawings and RA Attachment 7-3, Addendum A for hydrologic information pertaining to the soil borrow area.

762 Roads

No roads will be retained after reclamation of the site.

762.100 Restoring the Natural Drainage Patterns

Natural drainages will be restored during reclamation of the refuse pile area by removing the sediment pond and diversion ditches. As presented in Chapter 5, the existing topography will be altered by the construction of the refuse pile. This alteration will not significantly alter the natural drainage pattern of the area. This is because the site is located on a topographic divide between two small ephemeral drainages. RA Plate 7-3 presents the reclaimed drainages.

Two channels will be installed as part of the final reclamation (see RA Plates 5-2 and 7-3). Due to the proximity of the adjacent refuse, the channels will be designed to safely convey the peak flow resulting from the 100-year, 6-hour precipitation event. Table 7-3 summarizes the reclaimed channel configurations.

Erosive velocity has been determined to be 5 feet per second based on alluvial silts and fine gravels expected in the area (Chow, V.T., 1959. Open Channel Flow. McGraw-Hill Book Company, New York, New York. Page 680). For channels RD-1 and RD-2, riprap will only be installed in the steeper channel sections. A typical riprap cross section is provided in RA Attachment 7-4.

The cross-sections for the reclamation channel were designed using the minimum channel slope, while riprap sizing was designed using the maximum channel slope. Reclamation slopes were estimated from the topographic contours provided in RA Plate 7-3. Thickness of the riprap layer will be a minimum of 12". Sand filter blankets will be installed beneath the riprap at a thickness equal to one-half the thickness of the riprap or 6 inches; whichever is greater.

Since the site materials will be reworked during reclamation of the facility, pre-construction samples of channel bed materials would not likely be representative of reclamation conditions. Hence, no information is presented in this submittal regarding filter blanket sizing. Following regrading of the materials at the location of the reclamation channel, and prior to installation of the riprap, samples of the bed material will be collected and analyzed to determine soil gradations. The filter blanket will then be sized in accordance with standard practices at the time (e.g., Barfield et al., 1981) to determine the thickness and gradation of filter blanket materials.

762.200 Reshaping Cut and Fill Slopes

Through the use of contemporaneous reclamation, the fill slopes of the pile will be reclaimed as they are constructed. Section 540 describes the regrading process. All slopes will be shaped to be compatible with the post-mining land use and to complement the drainage pattern of the surrounding terrain.

763 Siltation Structures

763.100 Maintenance of Siltation Structures

All siltation structures will be maintained until removed in accordance with the approved reclamation plan.

763.200 Removal of Siltation Structures

The land on which the siltation structure were located will be regraded and revegetated in accordance with the reclamation plan presented in Section 540 of this amendment.

764 Structure Removal

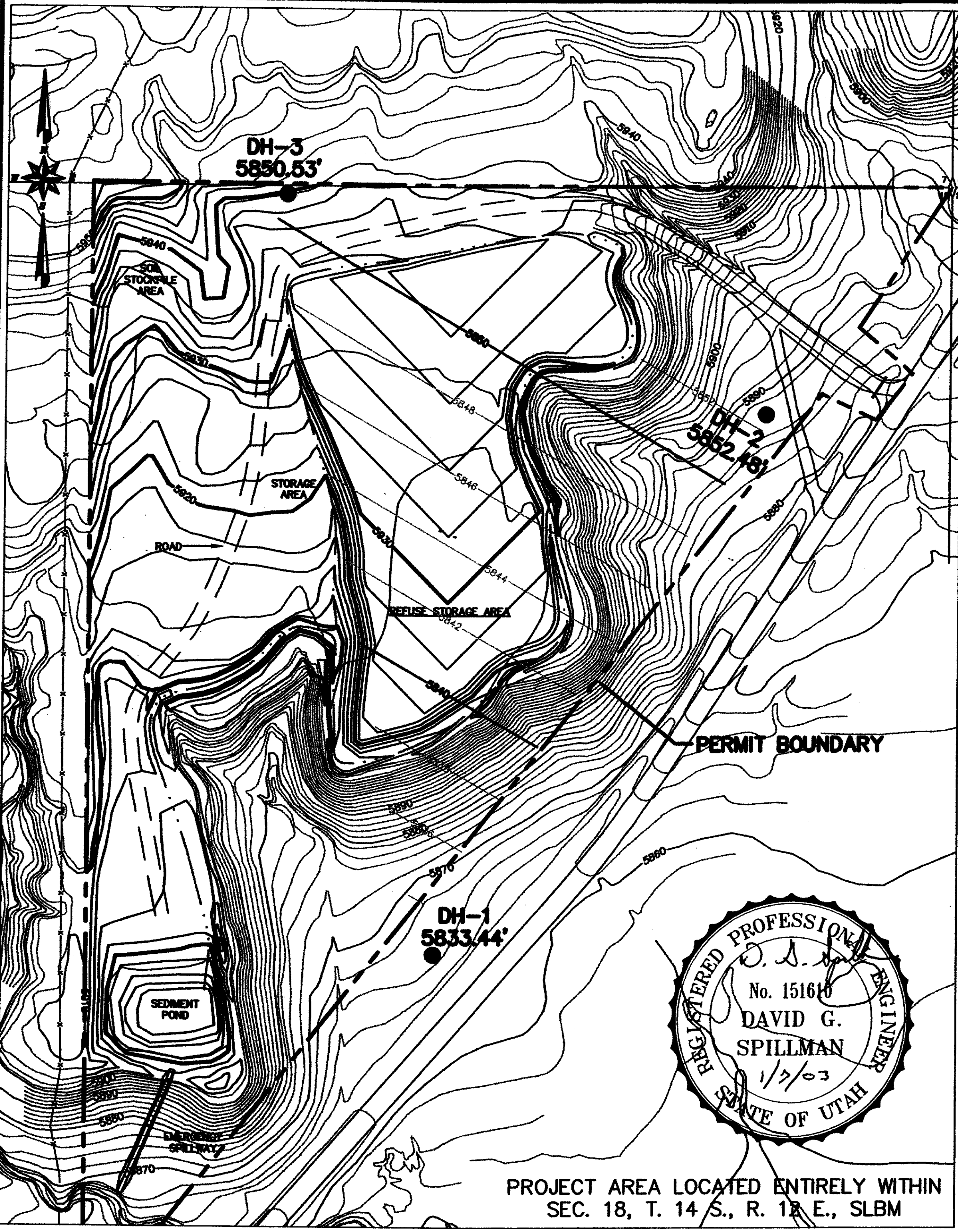
A timetable for the reclamation of the site is presented in RA Figure 5-1.

765 Permanent Casing and Sealing of Wells

When no longer required to monitor ground water levels in the area of the refuse pile or other use approved by the Division upon a finding of no adverse environmental or health and safety effects, or unless approved for transfer as a water well, each well will be capped, sealed, backfilled, or otherwise properly managed, as required by the Division. Permanent closure measures will be designed to prevent access.

765 Permanent Casing and Sealing of Wells

When no longer required to monitor ground water levels in the area of the refuse pile or other use approved by the Division upon a finding of no adverse environmental or health and safety effects, or unless approved for transfer as a water well, each well will be capped, sealed, backfilled, or otherwise properly managed, as required by the Division. Permanent closure measures will be designed to prevent access.



POTENTIOMETRIC SURFACE BASED ON
WATER ELEVATIONS MEASURED MARCH 25, 2002
ADDITIONAL WATER LEVEL DATA
CONTAINED IN RA ATTACHMENT 7-1.

0' 200'

OCT 11 2006

RA FIGURE 7-1. POTENTIOMETRIC SURFACE

RA TABLE 7-3
DIVERSION DESIGN SUMMARY

I.D. No.	Min. Bottom Width (ft)	Min. Channel Depth (ft)	Left Side Slope (xH:1V)	Right Side Slope (xH:1V)	Max. Flow Depth (ft)	Min. Slope (%)	Max. Slope (%)	Peak Flow (cfs)[a]	Req. Riprap D_{50} (ft)	Minimum Freeboard (ft)
OPERATIONAL DIVERSIONS										
DD-1	4.0	1.5	2.0	2.0	0.96	0.6	12.9	12.82	0.5*	0.54
DD-2a	15.0	1.0	2.0	2.0	0.22	1.9	10.0	8.02	None	0.78
DD-2b	4.0	1.0	2.0	2.0	0.41	5.0	13.5	8.02	0.5	0.59
DD-3a	15.0	1.0	2.0	2.0	0.37	1.3	3.5	16.03	None	0.63
DD-3b	2.0	1.5	2.0	2.0	1.03	1.3	9.0	16.03	0.5	0.47
UD-1a	1.0	1.0	2.0	2.0	0.27	2.0	15.0	0.71	None	0.73
UD-1b	2.0	1.5	2.0	2.0	0.87	0.3	2.8	4.74	None	0.63
UD-1c	2.0	1.0	2.0	2.0	0.5	4.4	23.3	4.74	0.5	0.5
RECLAMATION CHANNELS										
RD-1a	1.0	1.0	2.0	2.0	0.35	2.0	15.0	5.41	None	0.65
RD-1b	3.0	1.5	2.0	2.0	0.83	0.3	4.6	5.41	None	0.67
RD-1c	2.0	1.0	2.0	2.0	0.59	4.4	23.3	6.36	0.5	0.41
RD-2	1.0	1.0	2.0	2.0	0.37	1.0	14.3	0.71	None	0.63
RD-3	2.0	1.0	2.0	2.0	0.14	8.0	30.5	0.9	None	0.86
RD-4	1.0	1.0	2.0	2.0	0.19	2.8	6.1	0.41	None	0.81
RD-5	3.0	1.0	2.0	2.0	0.56	1.7	2.4	6.87	None	0.44
Swale 1	3.0	1.0	4.0	4.0	0.44	NA	NA	6.36	None	0.56

(a) Peak discharge resulting from the 100-year, 6-hour precipitation event.

* 6" only on slopes exceeding 4%.

RA TABLE 7-4

CULVERT DESIGN SUMMARY

Diversion Culvert	Minimum Diameter (in)	Culvert Material	Inlet Type	Culvert Slope (%)	Peak Flow (cfs) [a]	Outlet Velocity (fps)	Outlet Riprap D_{50} (in)
UC-1	24	CMP	Projecting	4.5	4.74	6.31	6
UC-2*	24	CMP	Projecting	1.5	6.78	4.66	None

(a) Peak discharge resulting from the 100-year, 6-hour precipitation event.

* Culvert UC-2 will be constructed only if the Topsoil Stockpile is relocated adjacent to the Dugout Canyon Road.

RA ATTACHMENT 7-1

BASELINE DATA

Surface Water Sampling Site SS-1

Sample Date	Flow (gpm)	pH (S.U.)	Conductivity (umhos)	Temperature (C)	Dissolved Oxygen (ppm)
05/08/98	No Flow				
07/01/98	No Flow				
09/21/98	No Flow				
09/07/99	No Flow				
09/15/99	No Flow				
10/21/99	No Flow				
12/21/99	No Flow				
3/29/00	No Flow				
06/06/00	No Flow				
09/22/00	No Flow				
11/27/00	No Flow				
01/11/01	No Flow				
06/14/01	No Flow				
09/20/01	No Flow				
12/10/01	No Flow				
3/25/02	No Flow				
4/13/02	No Flow				
7/31/02	No Flow				

Surface Water Sampling Site SS-2

Sample Date	Flow (gpm)	pH (S.U.)	Conductivity (umhos)	Temperature (C)	Dissolved Oxygen (ppm)
05/08/98	No Flow				
07/01/98	No Flow				
09/21/98	No Flow				
09/07/99	No Flow				
09/15/99	No Flow				
10/21/99	No Flow				
12/21/99	No Flow				
3/30/00	No Flow				
06/06/00	No Flow				
09/22/00	No Flow				
11/27/00	No Flow				
01/11/01	No Flow				
06/14/01	No Flow				
09/20/01	No Flow				
12/10/01	No Flow				
3/25/02	No Flow				
4/13/02	No Flow				
7/31/02	No Flow				

Groundwater Well Level - Site DH-1

Sample Date	Rim Elevation (feet)	Depth to Water (feet)	Water Elevation (feet)
12/02/98	5871.04	36.35	5834.69
12/02/99	5871.04	32.00	5839.04
3/30/00	5871.04	38.50	5832.54
06/06/00	5871.04	39.30	5831.74
09/22/00	5871.04	34.50	5836.54
11/27/00	5871.04	34.70	5836.34
01/11/01	5871.04	34.80	5836.24
06/14/01	5871.04	43.90*	5827.14
09/20/01	5871.04	38.40	5832.64
12/10/01	5871.04	38.50	5832.54
3/25/02	5871.04	37.60	5833.44
5/16/02	5871.04	39.10	5831.94
8/20/02	5871.04	40.79	5830.25

* Potential error in well depth reading.

Groundwater Well Level - Site DH-2

Sample Date	Rim Elevation (feet)	Depth to Water (feet)	Water Elevation (feet)
12/02/98	5891.58	41.24	5850.34
12/02/99	5891.58	42.00	5849.58
3/30/00	5891.58	41.50	5850.08
06/06/00	5891.58	40.80	5850.78
09/22/00	5891.58	41.90	5849.68
11/27/00	5891.58	39.80	5851.78
01/11/01	5891.58	39.50	5852.08
06/14/01	5891.58	44.10*	5847.48
09/20/01	5891.58	39.00	5852.58
12/10/01	5891.58	38.50	5853.08
03/25/02	5891.58	39.10	5852.48
5/16/02	5891.58	38.54	5853.04
8/20/02	5891.58	40.79	5850.79

* Potential error in well depth reading.

Groundwater Well Level - Site DH-3

Sample Date	Rim Elevation (feet)	Depth to Water (feet)	Water Elevation (feet)
12/02/98	5942.86	92.32	5850.54
12/02/99	5942.86	92.00	5850.86
3/30/00	5942.86	92.80	5850.06
06/06/00	5942.86	92.30	5850.56
09/22/00	5942.86	92.30	5850.56
11/27/00	5942.86	92.00	5850.86
01/11/01	5942.86	91.80	5851.06
06/14/01	5942.86	73.00*	5869.86
09/20/01	5942.86	92.20	5850.66
12/10/01	5942.86	92.40	5850.46
3/25/02	5942.86	92.33	5850.53
5/16/02	5942.86	93.50	5849.36
8/20/02	5942.86	96.66	5846.20

* Potential error in well depth reading.

RA ATTACHMENT 7-2

SEDIMENT POND DESIGN CALCULATIONS

REGISTERED PROFESSIONAL ENGINEER
2-11-05
No. 189797
LAYNE D.
JENSEN
Layne D. Jensen
STATE OF UTAH

EARTHFAX ENGINEERING, INC.
ENGINEERS / SCIENTISTS

PROJECT nc 801 08 PAGE 1 OF
COMPUTED LOJ DATE 2-1-05
CHECKED DATE

Dugout Canyon Mine Refuse Pile
Sedimentation Pond As-built Calculation

The entire area draining to the sedimentation pond has been defined as a single watershed (DWS-1). The entire watershed has been assumed to have a curve number of 90 (dirt road)

The runoff depth is controled by the curve number and precipitation event in the following equation.

$$Q = \frac{(P - 0.2S)^2}{P + 0.8S} \qquad S = \frac{1000}{CN} - 10 = 1.11$$

Assuming a 100-year 24-hour storm event $P = 2.8''$

$$Q = \frac{(2.8 - 0.2(1.11))^2}{2.8 + 0.8(1.11)} = 1.8''$$

Watershed Area = 644750 ft²

Runoff Volume = (644750)(1.8/12) = 96713 ft³ ⇒ 2.22 Ac-ft

This pond has a single open channel spillway, (RA Plate 7-2)

Spillway elevation = 5902.5 ft
BW = 10'
Left SS = 4:1
Right SS = 3:1
Crest length = 10'

Capacity at the bottom of the spillway = 2.89 Ac-ft (pg 2+3)
Total sediment capacity = 0.67 Ac-ft (Elevation = 5897.55)
60% cleanout volume = 0.40 Ac-ft (Elevation = 5896.5)

The hydraulic efficiency was assessed using SEDCAD (Warner and Schwab, 1992)

Assuming a 100-year 6-hour storm event beginning with the pond full the peak discharge is 9.73 cfs with a peak stage of 5903.0. Thus, the maximum flow depth is 6"

Minimum embankment elevation = 5905.0
Minimum freeboard = 2.0 ft

SEDCAD calculations can be found on Pgs 4-9

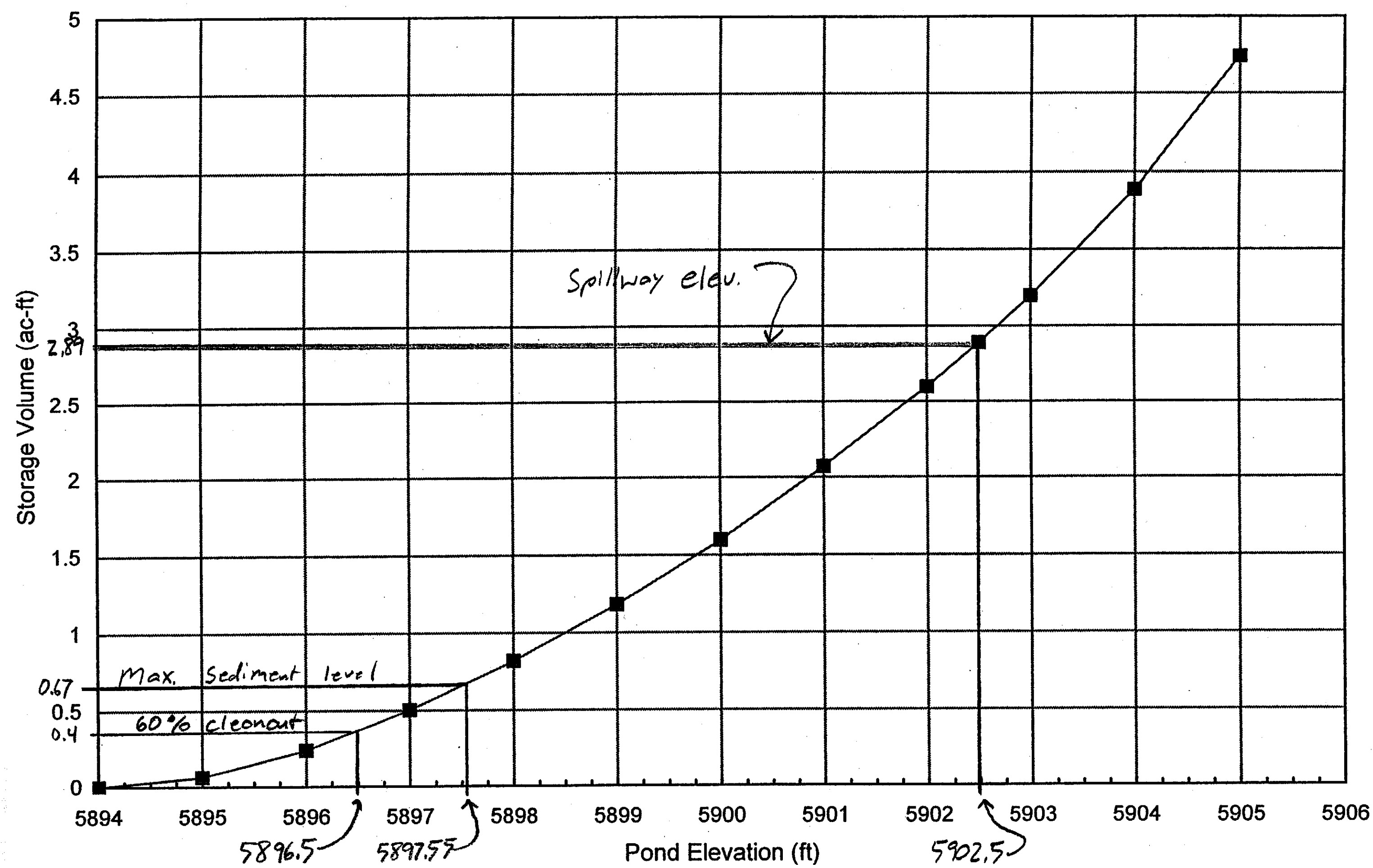
Dugout Canyon Mine Refuse Pile Sediment Pond

Stage-Capacity Table

Elevation (ft)	Area* (ft^2)	Average Area (ft^2)	Contour Interval (ft)	Incremental Volume (ft^3)	Cummulative Volume (ft^3)	Cummulative Volume (ac-ft)
5894	114					
		2742	1	2742	2742	0.06
5895	5370					
		7697	1	7697	10439	0.24
5896	10024					
		11415.5	1	11415.5	21854.5	0.50
5897	12807					
		13792.5	1	13792.5	35647	0.82
5898	14778					
		15754	1	15754	51401	1.18
5899	16730					
		18099.5	1	18099.5	69500.5	1.60
5900	19469					
		20646	1	20646	90146.5	2.07
5901	21823					
		23068	1	23068	113214.5	2.60
5902	24313					
		25177	0.5	12588.5	125803	2.89
5902.5	26041					
		26964	0.5	13482	139285	3.20
5903	27887					
		30017	1	30017	169302	3.89
5904	32147					
		37227	1	37227	206529	4.74
5905	42307					

* Determined from the topography of the existing pond (See RA Plate 7-2).

Stage-Capacity Curve
Refuse Pile Sediment Pond



3

CIVIL SOFTWARE DESIGN

SEDCAD+ Version 3

DUGOUT REFUSE PILE SEDIMENT POND

by

Name: LDJ

Company Name: EarthFax Engineering INC.
File Name: G:\UC801\08\POND

Date: 01-31-2005

Civil Software Design -- SEDCAD+ Version 3.1

Company Name: EarthFax Engineering INC.
Filename: G:\UC801\08\POND User: LDJ
Date: 01-31-2005 Time: 16:24:15
DUGOUT REFUSE PILE SEDIMENT POND
Storm: 2.05 inches, 100 year- 6 hour, SCS 6 Hour
Hydrograph Convolution Interval: 0.1 hr

SUBWATERSHED/STRUCTURE INPUT/OUTPUT TABLE

-Hydrology-

JBS	SWS	Area (ac)	CN	UHS	Tc (hrs)	K (hrs)	X	Base-Flow (cfs)	Runoff Volume (ac-ft)	Peak Discharge (cfs)
111	1	14.80	90	F	0.055	0.000	0.000	0.0	1.40	15.98
			Type: Pond			Label: POND				
111	Structure	14.80							1.40	
111	Total IN	14.80							1.40	15.98
111	Total OUT								1.40	9.73

Civil Software Design -- SEDCAD+ Version 3.1

Company Name: EarthFax Engineering INC.
Filename: G:\UC801\08\POND User: LDJ
Date: 01-31-2005 Time: 16:24:15
DUGOUT REFUSE PILE SEDIMENT POND
Storm: 2.05 inches, 100 year- 6 hour, SCS 6 Hour
Hydrograph Convolution Interval: 0.1 hr

POND INPUT/OUTPUT TABLE

J1, B1, S1
POND

Drainage Area from J1, B1, S1, SWS(s)1: 14.8 acres
Total Contributing Drainage Area: 14.8 acres

DISCHARGE OPTIONS:

	Emergency Spillway
Riser Diameter (in)	----
Riser Height (ft)	----
Barrel Diameter (in)	----
Barrel Length (ft)	----
Barrel Slope (%)	----
Manning's n of Pipe	----
Spillway Elevation	----
Lowest Elevation of Holes	----
# of Holes/Elevation	----
Entrance Loss Coefficient	----
Tailwater Depth (ft)	----
Notch Angle (degrees)	----
Weir Width (ft)	----
Siphon Crest Elevation	----
Siphon Tube Diameter (in)	----
Siphon Tube Length (ft)	----
Manning's n of Siphon	----
Siphon Inlet Elevation	----
Siphon Outlet Elevation	----
Emergency Spillway Elevation	5902.5
Crest Length (ft)	10.0
Z:1 (Left and Right)	4 3
Bottom Width (ft)	10.0

POND RESULTS:

Permanent Pool (ac-ft)
2.9

	Runoff Volume (ac-ft)	Peak Discharge (cfs)
IN	1.40	15.98
OUT	1.40	9.73

Peak Elevation	Hydrograph Detention Time (hrs)
5903.0	0.00

****

Civil Software Design -- SEDCAD+ Version 3.1

Company Name: EarthFax Engineering INC.
Filename: G:\UC801\08\POND User: LDJ
Date: 01-31-2005 Time: 16:24:15
DUGOUT REFUSE PILE SEDIMENT POND
Storm: 2.05 inches, 100 year- 6 hour, SCS 6 Hour
Hydrograph Convolution Interval: 0.1 hr

ELEVATION-DISCHARGE TABLE

J1, B1, S1
POND

Drainage Area from J1, B1, S1, SWS(s)1: 14.8 acres
Total Contributing Drainage Area: 14.8 acres

Elevation	Emergency Spillway (cfs)	Total Discharge (cfs)
5894.00	0.0	0.0
5894.50	0.0	0.0
5895.00	0.0	0.0
5895.50	0.0	0.0
5896.00	0.0	0.0
5896.50	0.0	0.0
5897.00	0.0	0.0
5897.50	0.0	0.0
5898.00	0.0	0.0
5898.50	0.0	0.0
5899.00	0.0	0.0
5899.50	0.0	0.0
5900.00	0.0	0.0
5900.50	0.0	0.0
5901.00	0.0	0.0
5901.50	0.0	0.0
5902.00	0.0	0.0
5902.50	0.0	0.0
5903.00	9.9	9.9
5903.10	11.8	11.8
5903.20	16.0	16.0
5903.30	20.6	20.6
5903.40	25.8	25.8
5903.50	30.9	30.9
5904.00	68.5	68.5
5904.50	118.4	118.4
5905.00	182.6	182.6

****

Civil Software Design -- SEDCAD+ Version 3.1

Company Name: EarthFax Engineering INC.
Filename: G:\UC801\08\POND User: LDJ
Date: 01-31-2005 Time: 16:24:15
DUGOUT REFUSE PILE SEDIMENT POND
Storm: 2.05 inches, 100 year- 6 hour, SCS 6 Hour
Hydrograph Convolution Interval: 0.1 hr

ELEVATION-AREA-CAPACITY-DISCHARGE TABLE

J1, B1, S1
POND

Drainage Area from J1, B1, S1, SWS(s)1: 14.8 acres
Total Contributing Drainage Area: 14.8 acres

SW#1: Emergency Spillway

Elev	Stage (ft)	Area (ac)	Capacity (ac-ft)	Discharge (cfs)	
5894.00	0.00	0.00	0.00	0.00	
5894.50	0.50	0.04	0.01	0.00	
5895.00	1.00	0.12	0.05	0.00	
5895.50	1.50	0.17	0.12	0.00	
5896.00	2.00	0.23	0.22	0.00	
5896.50	2.50	0.26	0.34	0.00	
5897.00	3.00	0.29	0.48	0.00	
5897.50	3.50	0.32	0.64	0.00	
5898.00	4.00	0.34	0.80	0.00	
5898.50	4.50	0.36	0.97	0.00	
5899.00	5.00	0.38	1.16	0.00	
5899.50	5.50	0.41	1.36	0.00	
5900.00	6.00	0.45	1.58	0.00	
5900.50	6.50	0.47	1.81	0.00	
5901.00	7.00	0.50	2.05	0.00	
5901.50	7.50	0.53	2.31	0.00	
5902.00	8.00	0.56	2.58	0.00	
5902.50	8.50	0.60	2.87	0.00	Stage of SW#1
5902.99	8.99	0.60	3.17	9.73	Peak Stage
5903.00	9.00	0.64	3.18	9.85	
5903.10	9.10	0.65	3.24	11.83	
5903.20	9.20	0.66	3.31	15.96	
5903.30	9.30	0.67	3.37	20.62	
5903.40	9.40	0.68	3.44	25.78	
5903.50	9.50	0.69	3.51	30.87	
5904.00	10.00	0.74	3.87	68.51	
5904.50	10.50	0.85	4.26	118.41	
5905.00	11.00	0.97	4.72	182.55	

As-built spillway verification.

The channel dimensions vary throughout the length of the spillway. The minimum channel dimensions will be assumed.

BW = 9'
SS = 1.75 : 1
Depth = 18"
D_{50} = 6"

minimum slope = 5.03 %

maximum slope = 30.4 %

To make the verification more conservative a peak flow equal to the peak inflow will be used instead of the calculated discharge rate

Q = 15.98 cfs

Maximum velocity = 6.54 ft/s. (pg 11)
6" riprap on a 1.75:1 slope can handle a velocity upto 7.0 fps.

Maximum Depth = 0.39 ft (pg 12)
Minimum Freeboard = 1.11 ft

References

Abt, S.R., Khattak, M.S., Nelson, J.D., Ruff, J.F., Shaikh, A., Wittler, R.J., Lee, D.W., and Hinkle, N.E. 1987. Development of Riprap Design Criteria by riprap testing in flumes: Phase I U.S. Nuclear Regulatory Commission. Washington D.C.

Searcy, J.K., 1967. Use of Riprap for bank protection. U.S. Dept. of Transportation, Bureau of Public Roads. U.S Government Printing office. Washington D.C.

Warner, R.C. and Schwab P.J., 1992 SEDCAD Version 3.0 Civil Software Design.

Emergency Spillway Max. Slope
Worksheet for Trapezoidal Channel

Project Description	
Worksheet	REFUSE PILE PONE
Flow Element	Trapezoidal Channel
Method	Manning's Formula
Solve For	Channel Depth

Input Data		
Mannings Coeffic	0.050	
Slope	304000	ft/ft
Left Side Slope	1.75	V : H
Right Side Slope	1.75	V : H
Bottom Width	9.00	ft
Discharge	15.95	cfs

$D_{50} = 6''$ Slope = 30.4 %

Results		
Depth	0.27	ft
Flow Area	2.4	ft²
Wetted Perim	9.61	ft
Top Width	9.30	ft
Critical Depth	0.46	ft
Critical Slope	0.051755	ft/ft
Velocity	6.54	ft/s
Velocity Head	0.66	ft
Specific Energ	0.93	ft
Froude Numb	2.25	
Flow Type	Supercritical	

< 7.0 fps ∴ ok

OCT 11 2005

Emergency Spillway Min. Slope
Worksheet for Trapezoidal Channel

Project Description	
Worksheet	REFUSE PILE PONI
Flow Element	Trapezoidal Channel
Method	Manning's Formula
Solve For	Channel Depth

Input Data		
Mannings Coeffic	0.038	$D_{50} = 6''$ Slope = 5%
Slope	050000	ft/ft
Left Side Slope	1.75	V : H
Right Side Slope	1.75	V : H
Bottom Width	9.00	ft
Discharge	15.95	cfs

Results		
Depth	0.39	ft << 1.5 ft min, freeboard = 1.11 ft
Flow Area	3.6	ft²
Wetted Perim	9.89	ft
Top Width	9.44	ft
Critical Depth	0.46	ft
Critical Slope	0.029189	ft/ft
Velocity	4.47	ft/s
Velocity Head	0.31	ft
Specific Enerç	0.70	ft
Froude Numbi	1.28	
Flow Type	Supercritical	

OCT 11 2006

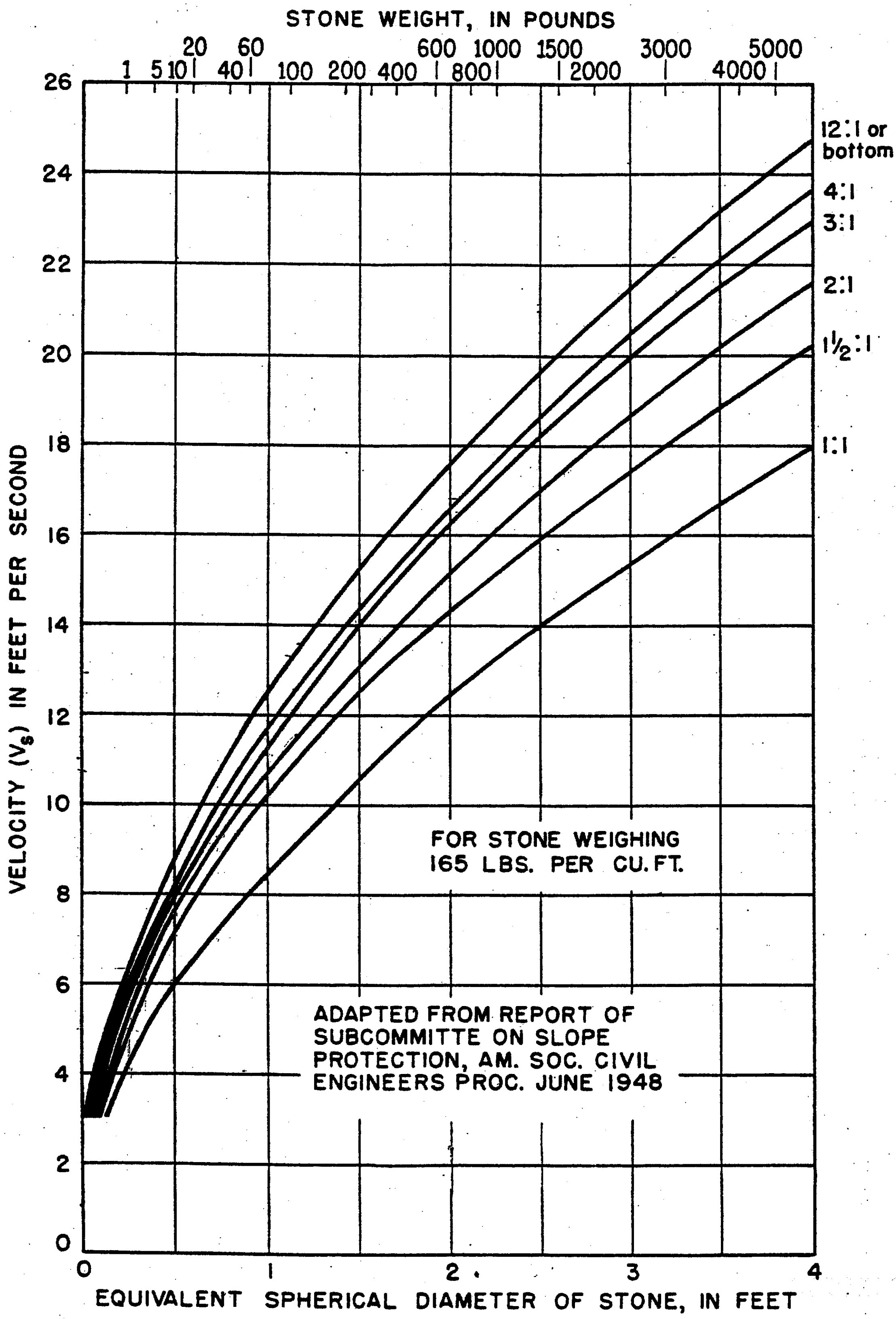


FIG. 2-SIZE OF STONE THAT WILL RESIST DISPLACEMENT FOR VARIOUS VELOCITIES AND SIDE SLOPES

Searcy, J.K. 1967. Use of Riprap for Bank Protection, U.S. Dept. of Transportation, Bureau of Public Roads, U.S Government Printing Office, Washington D.C.

RA ATTACHMENT 7-3

ENERGY DISSIPATION BASIN CALCULATIONS

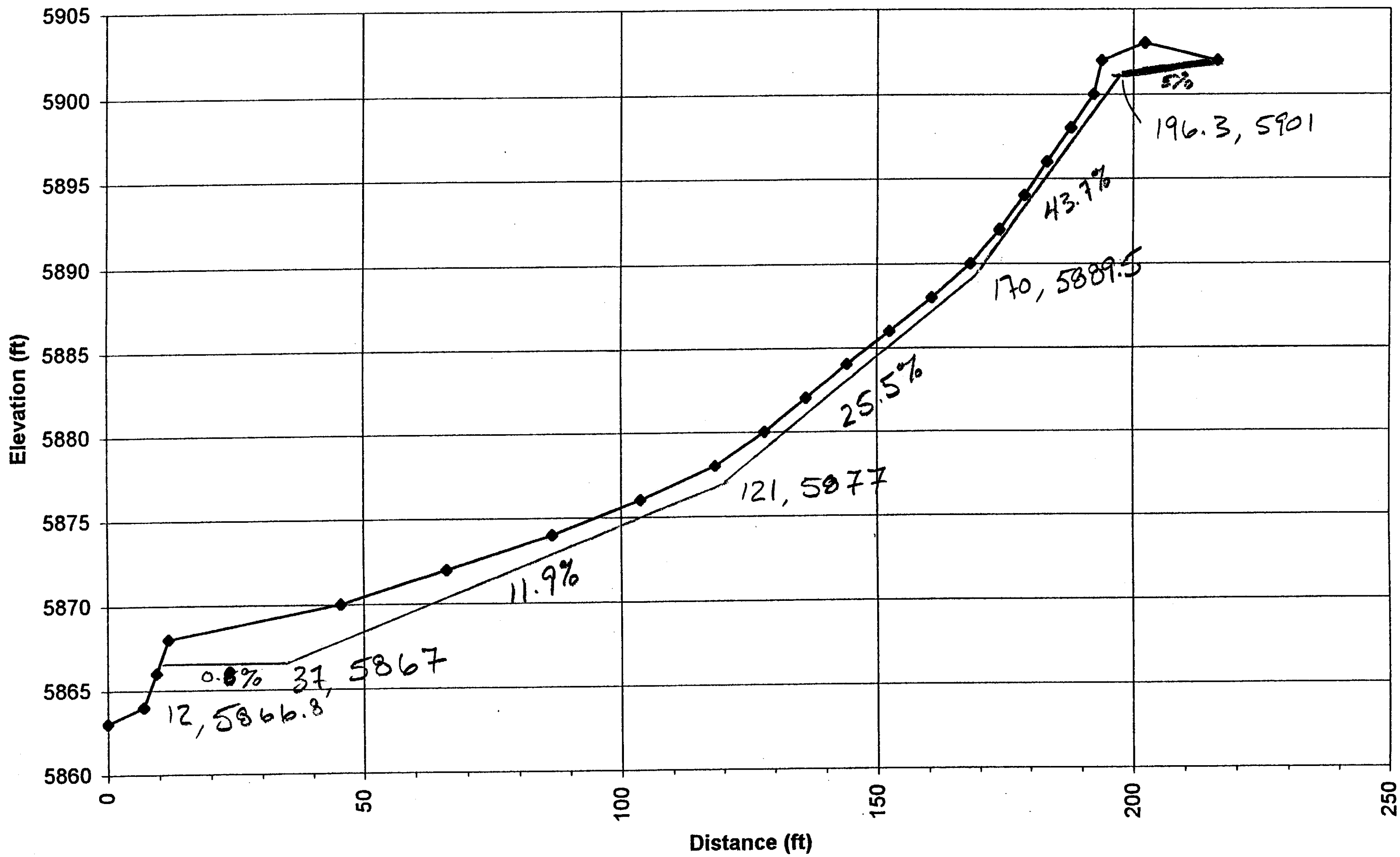
RA ATTACHMENT 7-3

ENERGY DISSIPATION BASIN CALCULATIONS

LICENSED PROFESSIONAL ENGINEER
No. 168246
RICHARD B.
WHITE
4/10/2002
STATE OF UTAH

MAR 0 3 2003

Spillway Profile



MAR 0 3 2003

Table 1

Spillway Profile

Elev	Dist
5863	0
5864	7
5866	9.5
5868	11.8
5870	45.5
5872	66.13
5874	86.6
5876	103.8
5878	118.5
5880	128.2
5882	136.3
5884	144.3
5886	152.5
5888	160.7
5890	168.3
5892	174
5894	178.9
5896	183.3
5898	187.9
5900	192.3
5902	193.9
5903	202.3
5902	216.3

Emergency Spillway - Crest Section
Worksheet for Trapezoidal Channel

Project Description	
Worksheet	Spillway - Crest Section
Flow Element	Trapezoidal Channel
Method	Manning's Formula
Solve For	Channel Depth

Input Data		
Mannings Coefficient	0.035	– 6 in D_{50} RIPRAP
Slope	0.050000 ft/ft	
Left Side Slope	2.00 H : V	
Right Side Slope	2.00 H : V	
Bottom Width	6.00 ft	
Discharge	14.81 cfs	

Results		
Depth	0.44 ft	
Flow Area	3.0 ft²	
Wetted Perimeter	7.95 ft	
Top Width	7.74 ft	
Critical Depth	0.54 ft	
Critical Slope	0.023954 ft/ft	
Velocity	4.95 ft/s	OK < 6.5 FPS
Velocity Head	0.38 ft	
Specific Energy	0.82 ft	
Froude Number	1.40	
Flow Type	Supercritical	

MAR 0 3 2003

Emergency Spillway - Upper Outslope Section
Worksheet for Trapezoidal Channel

Project Description	
Worksheet	Spillway-Max Slope-Upper
Flow Element	Trapezoidal Channel
Method	Manning's Formula
Solve For	Channel Depth

Input Data		
Mannings Coefficient	0.039	- 12 INCH D50 RIPRAP
Slope	0.437000 ft/ft	
Left Side Slope	2.00 H : V	
Right Side Slope	2.00 H : V	
Bottom Width	6.00 ft	
Discharge	14.81 cfs	

Results		
Depth	0.25 ft	
Flow Area	1.6 ft²	
Wetted Perimeter	7.10 ft	
Top Width	6.98 ft	
Critical Depth	0.54 ft	
Critical Slope	0.029743 ft/ft	
Velocity	9.30 ft/s	- OK < 9.5FPS
Velocity Head	1.34 ft	
Specific Energy	1.59 ft	
Froude Number	3.43	
Flow Type	Supercritical	

MAR 03 2003

Emergency Spillway - Lower Outslope Section
Worksheet for Trapezoidal Channel

Project Description	
Worksheet	Spillway-Max Slope-Lower
Flow Element	Trapezoidal Channel
Method	Manning's Formula
Solve For	Channel Depth

Input Data		
Mannings Coefficient	0.039	- 12 inch D_{50} RIPRAP
Slope	0.255000 ft/ft	
Left Side Slope	2.00 H : V	
Right Side Slope	2.00 H : V	
Bottom Width	6.00 ft	
Discharge	14.81 cfs	

Results		
Depth	0.29 ft	
Flow Area	1.9 ft²	
Wetted Perimeter	7.29 ft	
Top Width	7.15 ft	
Critical Depth	0.54 ft	
Critical Slope	0.029743 ft/ft	
Velocity	7.83 ft/s	– OK < 9.5 FPS
Velocity Head	0.95 ft	
Specific Energy	1.24 ft	
Froude Number	2.68	
Flow Type	Supercritical	

MAR 0 3 2003

Emergency Spillway - Minimum Slope
Worksheet for Trapezoidal Channel

Project Description	
Worksheet	Spillway - Minimum Slope
Flow Element	Trapezoidal Channel
Method	Manning's Formula
Solve For	Channel Depth

Input Data		
Mannings Coefficient	0.037	- 9 INCH D_{50} RIPRAP
Slope	0.119000 ft/ft	
Left Side Slope	2.00 H : V	
Right Side Slope	2.00 H : V	
Bottom Width	6.00 ft	
Discharge	14.81 cfs	

Results		
Depth	0.35 ft	
Flow Area	2.3 ft²	
Wetted Perimeter	7.56 ft	
Top Width	7.40 ft	
Critical Depth	0.54 ft	
Critical Slope	0.026770 ft/ft	
Velocity	6.33 ft/s	- OK < 8.0 FPS
Velocity Head	0.62 ft	
Specific Energy	0.97 ft	
Froude Number	1.99	
Flow Type	Supercritical	

MAR 0 3 2003

Emergency Spillway - Dissipator Section
Worksheet for Trapezoidal Channel

Project Description	
Worksheet	Spillway - Energy Dissipator
Flow Element	Trapezoidal Channel
Method	Manning's Formula
Solve For	Channel Depth

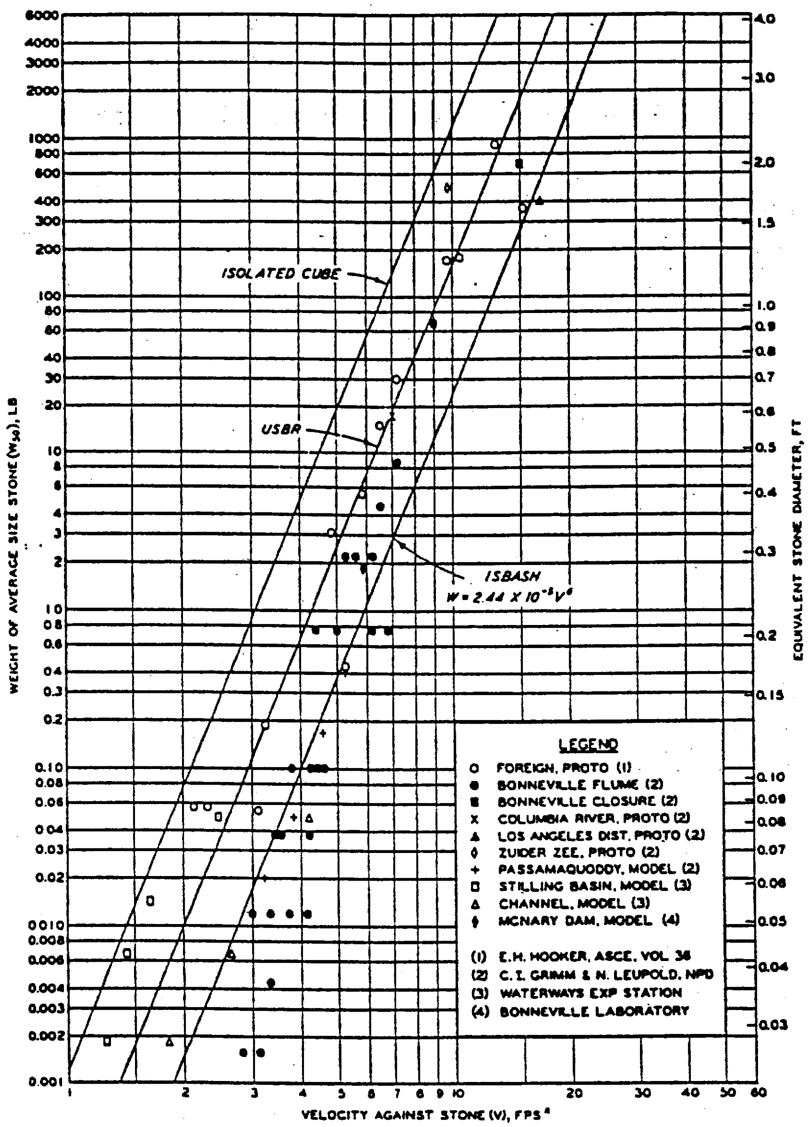
Input Data		
Mannings Coefficient	0.037	– 9 INCH D_{50} RIPRAP
Slope	0.005000 ft/ft	
Left Side Slope	2.00 H : V	
Right Side Slope	2.00 H : V	
Bottom Width	6.00 ft	
Discharge	14.81 cfs	

Results		
Depth	0.87 ft	
Flow Area	6.7 ft²	
Wetted Perimeter	9.89 ft	
Top Width	9.48 ft	
Critical Depth	0.54 ft	
Critical Slope	0.026770 ft/ft	
Velocity	2.20 ft/s	OK < 8.0 FPS
Velocity Head	0.08 ft	
Specific Energy	0.95 ft	
Froude Number	0.46	
Flow Type	Subcritical	

MAR 0 3 2003

EARTHFAX ENGINEERING, INC.
ENGINEERS / SCIENTISTS

PROJECT ______ PAGE ______ OF ______
COMPUTED ______ DATE ______
CHECKED ______ DATE ______



NOTE: SPECIFIC WEIGHT OF ROCK = 165 LB/CU FT.
*FOR STONE PROTECTION BELOW ENERGY DISSIPATORS USE AS AVERAGE VELOCITY ACROSS END SILL

MAR 0 3 2003

VELOCITY VS STONE WEIGHT

SEE TEXT PAGE 36

Plate 29

FROM: U.S. ARMY CORPS OF ENGINEERS, 1970. HYDRAULIC DESIGN OF FLOOD CONTROL STRUCTURES. EM-1110-2-1601.

RA ATTACHMENT 7-3

TOPSOIL/SUBSOIL STOCKPILE SEDIMENT CONTROL

REGISTERED PROFESSIONAL ENGINEER
1-20-05
No. 189797
LAYNE D.
JENSEN
STATE OF UTAH

EARTHFAX ENGINEERING, INC.
ENGINEERS / SCIENTISTS

PROJECT UC 801-08 PAGE ___ OF ___
COMPUTED LOJ DATE 2-3-05
CHECKED ___ DATE ___

Topsoil Stockpile Sediment Control

A berm will be placed around the entire topsoil stockpile to contain all runoff from the topsoil stockpile. The berm has been designed to completely contain the 10-yr 24-hour storm event with a spillway through a silt fence to handle a larger event.

Rainfall depth = 1.95 in (10-yr 24-hr)

Although the topsoil pile will be gouged and reseeded a bare earth condition will be assumed with a hydrologic soil group of B

CN = 82 (dirt road)

$$\text{Runoff depth} = \frac{(P-0.2S)^2}{P+0.8S}$$

$$S = 1000/CN - 10 = \frac{1000}{82} - 10 = 2.2$$

$$\text{Runoff depth} = \frac{(1.95-(0.2)(2.2))^2}{1.95+0.8(2.2)} = 0.61 \text{ inch}$$

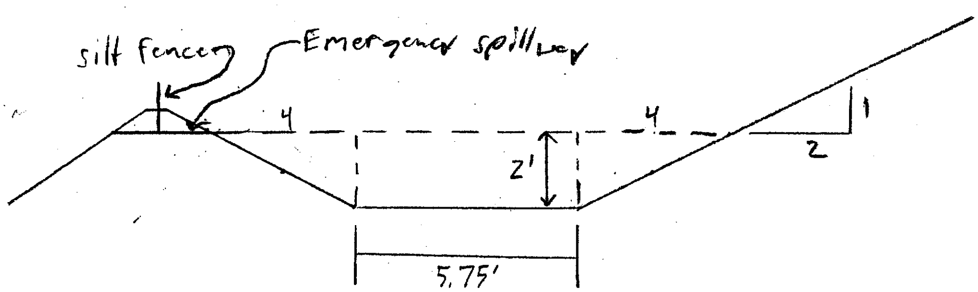
Topsoil stockpile Area = 31,148 ft^2

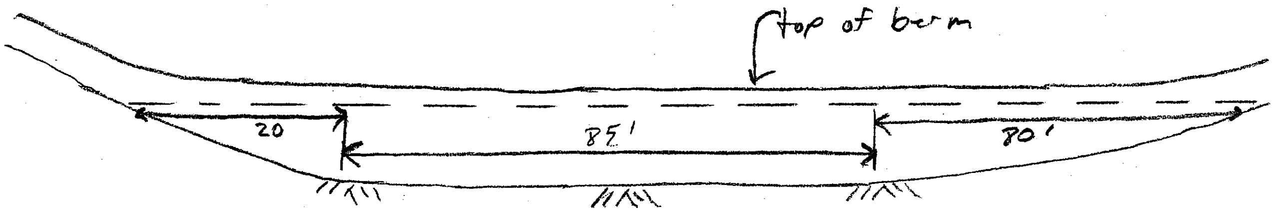
Total runoff $= \left(\frac{0.61}{12}\right)(31,148\ ft^2) = 1595\ ft^3$

Runoff will be split roughly equally between a north and south containment area.

<u>North containment</u>

Containment Area = $(2)(5.75) + (2)(4) = 19.5\ ft^2$





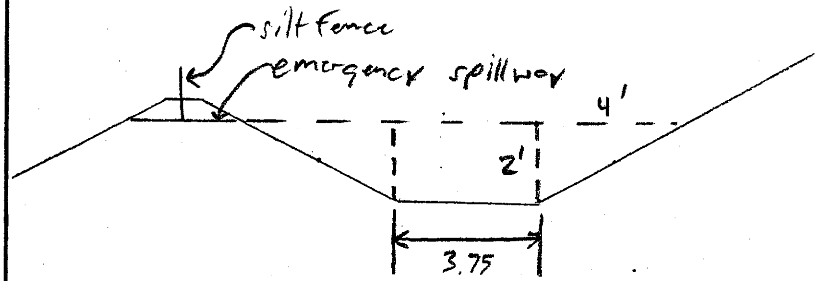
space between berm and pile is only 2.5' here reduce vol. by 2/3

$$Vol = (19.5\,ft^2)(85') + \tfrac{1}{2}(19.5)(20) + (\tfrac{1}{2})(\tfrac{1}{3})(19.5)(80)$$

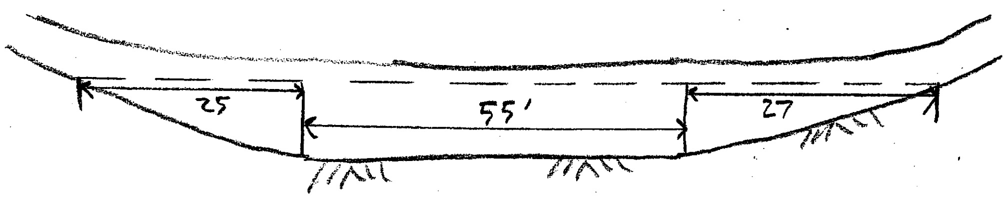
$$= 1657.5 + 195 + 234 = 2086.5\ ft^3$$

This side of the containment can hold the entire storm event with 491.5 ft^3 to spare.

South containment



$$\text{Containment area} = (2)(3.75) + (2)(4) = 15.5\ ft^2$$



$$\text{Containment vol.} = (55)(15.5') + \tfrac{1}{3}(25)(15.5) + \tfrac{1}{3}(27)(15.5) = 1121.0\ ft^3$$

This side of the containment can handle well over half of the total runoff.

EARTHFAX ENGINEERING, INC.
ENGINEERS / SCIENTISTS

PROJECT UC 801-08 PAGE ___ OF ___
COMPUTED LOJ DATE 2-3-05
CHECKED ___ DATE ___

Subsoil Stockpile Sediment Control

Sediment control for the subsoil stockpile will be configured the same as for the topsoil stockpile. However, the subsoil will shed a greater percentage of the precipitation.

Assume hydrologic soil group C

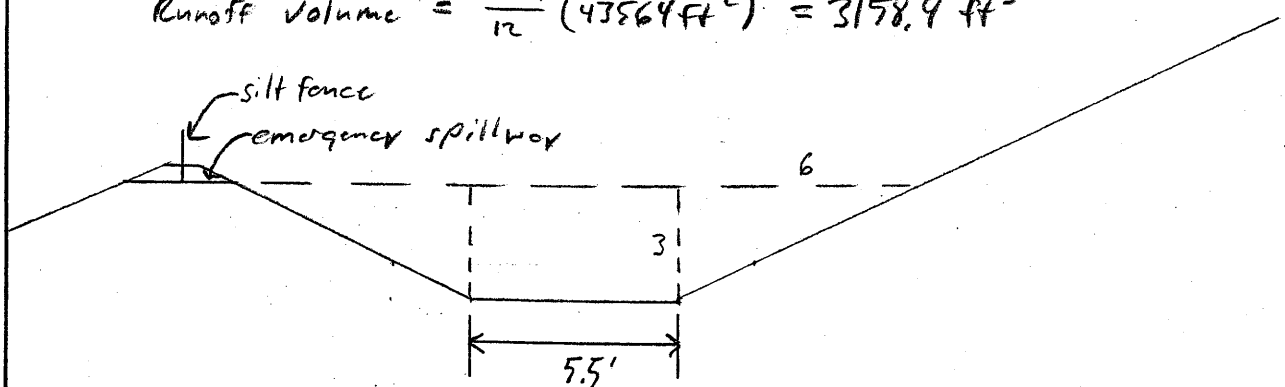
$$CN = 87 \quad \text{(Dirt road)}$$

$$S = \frac{1000}{87} - 10 = 1.49$$

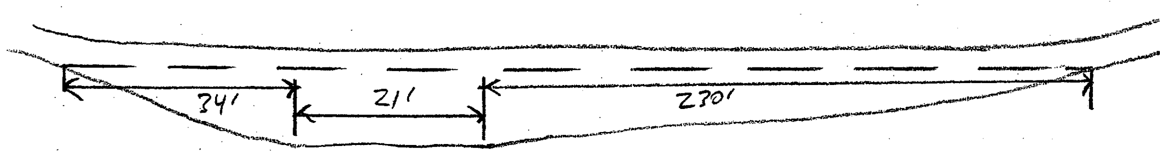
$$\text{Runoff depth} = \frac{(1.95 - 0.2(1.49))^2}{1.95 + 0.8(1.49)} = 0.87 \text{ in}$$

$$\text{Stockpile Area} = 43564 \text{ ft}^2$$

$$\text{Runoff volume} = \frac{0.87}{12}(43564 \text{ ft}^2) = 3158.4 \text{ ft}^3$$



$$\text{Containment Area} = (5.5)(3) + (3)(6) = 34 \text{ ft}^2$$



$$\text{Containment vol} = (21)(34) + \tfrac{1}{2}(34)(34) + \tfrac{1}{3}(230)(34) = 3899 \text{ ft}^3$$

$$3899 > 3158.4 \quad \therefore \quad \text{Adequate containment}$$

OCT 11 2006

RA ATTACHMENT 7-3, ADDENDUM A

TOPSOIL/SUBSOIL BORROW AREA

Borrow Area Hydrology

When the refuse pile is reclaimed some of the cover material will come from the soil borrow area. The soil borrow area will only be impacted during the short period during which the refuse pile is being reclaimed. Reclamation of the site will occur immediately after the required volume of soil has been removed. The soil borrow area is a little under a mile from the refuse pile. The site has a gentle 3 to 4% slope to the south towards an incised ephermeral channel flowing to the southeast. The site is dry with limited vegetation typical of the area, namely, sage brush and grasses. Climatological information for the area can be seen in Appendix 4-1 of the approved M&RP and in RA Attachment 7-5.

Soil in the area is easily erodible as demonstrated by the gullies running through the site with depths ranging between 6 and 20 feet. Gullies in the area are typically 8 to 10 feet deep. The 20 foot deep gully through the site indicates that soil has a depth of at least 20 feet. The following sections discuss how degradation of groundwater and surface water will be avoided during soil removal activities and reclamation.

Groundwater

The effect on groundwater from soil removal activities is expected to be minimal. No springs are evident at the soil borrow area or in areas upgradient of the soil borrow area. The deep gullies at the site are dry. Thus, it can be concluded that groundwater is at least below the deepest gully, which is approximately 20 feet deep. Thus, groundwater at the site is well below the 3 to 4 foot depth of soil to be removed from the site and therefore will not be encountered during soil removal activities. Based on the monitoring wells around the refuse pile the depth to groundwater in this area can be expected to be 30 to 40 feet below ground surface. Since the only activity at the site will be soil removal, there is very little potential for groundwater impact. Therefore groundwater quality will not be monitored.

Surface Water

All of the drainages in the vicinity of the soil borrow area are ephemeral in nature and only flow in response to large storm events and snow melt. Runoff from areas upgradient of the soil borrow area are collected into gullies before reaching the soil borrow area. These gullies convey runoff through the site with some runoff flowing into the gullies from the soil borrow area. The watershed upgradient of the site is less than 60 acres in size. Thus, the gullies at the site represent ephemeral drainages according to the definition of an ephemeral drainage in the regulations.

To protect the hydrologic balance, soil removal activities and reclamation activities will be conducted in a manner that prevents, to the extent possible, additional contributions of suspended solids to streamflow outside the permit area, and otherwise prevent water pollution. During soil removal activities and reclamation CFC will maintain adequate runoff- and sediment-control facilities to protect local surface waters.

Access to the soil borrow area will require the crossing of a channel. This channel flows only in response to storm events or snow melt. A broad swale will be constructed to cross the drainage. Soil removal activities will only occur if the channel is dry. To facilitate removal of the soil and to reduce sediment from the swale, the swale may be covered with clean gravel. Soil removed to create the swale will be replaced to the extent possible during reclamation. However, the drainage has vertical sides in most places but the soil can only be replaced to a maximum slope of 2:1. The swale crossing will be reclaimed such that there are no sharp changes in slope or direction. The reclaimed slopes of the swale will be deep gouged and seeded following regrading. The reclaimed channel will have the same bottom width as the undisturbed channel and will be composed of the same material as the rest of the channel. The undisturbed channel is composed of the same soil as that being removed with an occasional rock. The reclaimed swale will be more stable than the undisturbed channel due to the side slopes being laid back rather than being vertical.

During soil removal and reclamation activities a combination of sediment control methods will be used. Before commencing any soil removal activities silt fences will be installed down gradient of any areas to be disturbed. After installation of the silt fences the top twelve inches of soil will be pushed into berms around the site. These berms will contain runoff that falls within the borrow area and will divert upgradient runoff around the borrow area. The removal of 3 to 4 feet of soil from the site will, by the nature of the activity, create a depression that will contain the runoff from inside the soil borrow area. The silt fences will be maintained during soil removal activities to provide sediment treatment in addition to the berms and depression.

To minimize the impact to the site the soil will be removed from between the gullies running through the site. Thus, the current drainage pattern will not be impacted by soil removal activities. The gullies on either side of the soil borrow area are much deeper than the expected soil excavation depth. Therefore, after 3 to 4 feet of soil is removed, the site will be regraded to drain towards the one of the existing gullies. By removing soil in this manner no reclamation drainages will need to be constructed.

During reclamation the silt fences will be removed during final grading. Once the silt fences are removed the site will be deep gouged, mulched and seeded as soon as possible. The silt fences will not be removed if a storm is expected in the time between when the silt fences are removed and when the site can be deep gouged. Deep gouging has been demonstrated to be very effective at controlling sediment from reclaimed sites, especially from relatively flat sites such as this. The deep gouges will also promote revegetation of the site.

Canyon Fuel Company, LLC
Dugout Canyon Mine

Refuse Pile Amendment
January 2006

RA ATTACHMENT 7-4

HYDROLOGY CALCULATIONS

REGISTERED PROFESSIONAL ENGINEER
1-23-06
No. 189797
LAYNE D.
JENSEN
STATE OF UTAH

RA ATTACHMENT 7-4

DIVERSION AND CULVERT DESIGN CALCULATIONS

REGISTERED PROFESSIONAL ENGINEER
2-11-05
No. 189797
LAYNE D.
JENSEN
STATE OF UTAH

Dugout Canyon Mine Refuse Pile
Hydrology Calculations

Rainfall Depths

Since this site is a refuse pile the 100-year storm event will be used for all calculations

100-year 6-hour	2.05 inches
100-year 24-hour	2.80 inches

Curve Number

This area was a gravel pit prior to being used as a refuse pile. Thus, the vast majority of the disturbed areas have no vegetation and little if any soil remaining. The entire site whether covered with waste rock or bare soil will behave like a dirt road. The typical curve number for dirt roads is 90.

The undisturbed portions of any watersheds are typically Pinyon/Juniper or Sagebrush/Grass vegetation type. The majority being Pinyon/Juniper. Undisturbed soils in the undisturbed watersheds have a hydrologic soil of B. Combining the vegetation type and hydrologic soil type the estimated curve number is 75.

Soil from the site and a borrow area will be used to reclaim the site. Although the native soils justify a lower curve number the uncertainty regarding the soil borrow source justifies a conservative choice of 80 for the reclaimed areas.

A summary of watershed characteristics can be found on the following pages.

Drainage Ditch Design

Assumptions

1. All ditches designed for the 100-yr 6-hr storm event,

2. When riprap is required the method presented by Searcy, (1967) will be used,

3. Riprap thickness is twice the D_{50},

4. A Mannings n of 0.03 will be assumed for bare earth,

5. A Mannings n of 0.035 will be assumed for rocky earth,

6. A Mannings n for riprap channels will be determined using the method presented by Abt, S.R., et. al. (1987)

$$n = 0.0456(D_{50} \times \text{Slope})^{0.159}$$

Where: D50 = median riprap size (inches)
Slope = (ft\ft)

7. A geotextile will be used beneath riprap for operational ditches,

8. A filter blanket will be used beneath the riprap for all reclamation channels. The filter thickness will be half of the riprap thickness.

Operational Ditches and Culvert

UD-1a

Contributing Watershed is Approximately 15% of UWS-1

Peak Flow = 4.74 x 0.15 = 0.71 cfs

Minimum Slope = 2.0%
Maximum Slope = 15.0%

Trapizoidal Ditch
Side slopes = 2:1
Depth = 1 ft
Bottom Width = 1 ft
Riprap = none

Maximum Velocity = 4.59 fps
Maximum Depth = 0.27 ft
Freeboard = 0.73 ft

See pages 22 and 23 for calculation sheets and page 56 for a typical cross-section of the ditch

UD-1b

Contributing Watershed is UWS-1

Peak Flow = 4.74 cfs

Minimum Slope = 0.3%
Maximum Slope = 2.8%

Trapizoidal Ditch
Side slopes = 2:1
Depth = 1.5 ft
Bottom Width = 2 ft
Riprap = none

Maximum Velocity = 3.92 fps
Maximum Depth = 0.87 ft
Freeboard = 0.63 ft

See pages 24 and 25 for calculation sheets and page 57 for a typical cross-section of the ditch

UD-1c

Contributing Watershed is UWS-1

Peak Flow = 4.74 cfs
Minimum Slope = 4.4%
Maximum Slope = 23.3%

Trapizoidal Ditch
Side slopes = 2:1
Depth = 1.0 ft
Bottom Width = 2.0 ft
Riprap = 6 inch

Maximum Velocity = 6.26 fps
Maximum Depth = 0.5 ft
Freeboard = 0.5 ft

See pages 26 and 27 for calculation sheets and page 58 for a typical cross-section of the ditch

A single watershed has been defined for the area draining to the sediment pond. Since the refuse pile may slope in different directions during construction ditches DD-1 and DD-2 may receive most of the runoff. Thus, both ditches will be designed to handle the majority of the runoff from the upper part of the watershed.

DD-1

Contributing Watershed is Approximately 80% of DWS-1

Peak Flow = 16.03 x 0.8 = 12.82 cfs
Minimum Slope = 0.6%
Maximum Slope = 12.9%

Trapizoidal Ditch
Side slopes = 2:1
Depth = 1.5 ft
Bottom Width = 4 ft
Riprap = 6 inch on slopes exceeding a slope of 4%. A few places have short areas with slopes exceeding 4%, these areas will need to be riprapped.

Maximum Velocity = 6.22 fps
Maximum Depth = 0.96 ft
Freeboard = 0.54 ft

See pages 28, 29, and 30 for calc sheets and page 59 and 60 for a typ. cross-section of the ditch

DD-2a

Contributing Watershed is Approximately 50% of DWS-1

Peak Flow = 16.03 x 0.5 = 8.02 cfs

Minimum Slope = 1.9%
Maximum Slope = 10.0%

Trapizoidal Ditch
Side slopes = 2:1
Depth = 1 ft
Bottom Width = 15 ft
Riprap = none

Maximum Velocity = 4.03 fps
Maximum Depth = 0.22 ft
Freeboard = 0.78 ft

See pages 31 and 32 for calculation sheets and page 61 for a typical cross-section of the ditch

DD-2b

Contributing Watershed is Approximately 50% of DWS-1

Peak Flow = 16.03 x 0.5 = 8.02 cfs

Minimum Slope = 5.0%
Maximum Slope = 13.5%

Trapizoidal Ditch
Side slopes = 2:1
Depth = 1 ft
Bottom Width = 4 ft
Riprap = 6 inch

Maximum Velocity = 5.57 fps
Maximum Depth = 0.41 ft
Freeboard = 0.59 ft

See pages 33 and 34 for calculation sheets and page 62 for a typical cross-section of the ditch

DD-3a

Contributing Watershed is DWS-1

Peak Flow = 16.03 x 1.0 = 16.03 cfs

Minimum Slope = 1.3%
Maximum Slope = 3.5%

Trapizoidal Ditch
Side slopes = 2:1
Depth = 1.0 ft
Bottom Width = 15.0 ft
Riprap = none

Maximum Velocity = 3.84 fps
Maximum Depth = 0.37 ft
Freeboard = 0.63 ft

See pages 35 and 36 for calculation sheets and page 63 for a typical cross-section of the ditch

DD-3b

Contributing Watershed is DWS-1

Peak Flow = 16.03 x 1.0 = 16.03 cfs

Minimum Slope = 1.3%
Maximum Slope = 9.0%

Trapizoidal Ditch
Side slopes = 2:1
Depth = 1.5 ft
Bottom Width = 2.0 ft
Riprap = 6 inch

Maximum Velocity = 7.28 fps
Maximum Depth = 1.03 ft
Freeboard = 0.47 ft

See pages 37 and 38 for calculation sheets and page 64 for a typical cross-section of the ditch

Culvert

UC-1

Culvert Diameter = 24 inches

Contributing Watershed = UWS-1

Peak Flow = 4.74 cfs

Culvert Slope = 4.5 %

Culvert inlet capacity = 11.9 cfs (projecting inlet)

Culvert capacity based on culvert slope = 26.11 cfs

Culvert capacity is controlled by the inlet. However, the inlet capacity is still over twice the peak flow from the 100-year 6-hour.

Outlet velocity = 6.31 fps thus outlet protection is needed (pg 39)

Place D_{50} = 6 inch riprap at the outlet for outlet protection

UC-2

Culvert Diameter = 24 inches

Contributing Watershed = UWS-2

Peak Flow = 6.78 cfs

Culvert Slope = 1.5 %

Culvert inlet capacity = 11.9 cfs (projecting inlet)

Culvert capacity based on culvert slope = 15.01 cfs

Culvert capacity is controlled by the inlet. However, the inlet capacity is still over twice the peak flow from the 100-year 6-hour.

Outlet velocity = 4.66 fps thus outlet protection is not needed (pg 40)

mod 1-06

RECLAMATION CHANNELS

RD-1a

Contributing Watershed is Approximately 15% of RWS-1

Peak Flow = 6.55 x 0.15 = 0.98 cfs

Minimum Slope = 4.86%
Maximum Slope = 13.59%

Trapizoidal Ditch
Side slopes = 2:1
Depth = 1 ft
Bottom Width = 1 ft
Riprap = none

Maximum Velocity = 4.46 fps
Maximum Depth = 0.27 ft
Freeboard = 0.73 ft

See pages 41 and 42 for calculation sheets and page 65 for a typical cross-section of the ditch

RD-1b

Contributing Watershed is 85% of RWS-1

Peak Flow = 6.55 x 0.85 = 5.57 cfs

Minimum Slope = 0.68%
Maximum Slope = 3.24%

Trapizoidal Ditch
Side slopes = 2:1
Depth = 1.25 ft
Bottom Width = 3 ft
Riprap = none

Maximum Velocity = 4.28 fps
Maximum Depth = 0.66 ft
Freeboard = 0.59 ft

See pages 43 and 44 for calculation sheets and page 66 for a typical cross-section of the ditch

mod 1-06

RD-1c

Contributing Watershed is RWS-1

Peak Flow = 6.55 cfs
Minimum Slope = 4.4%
Maximum Slope = 23.3%

Trapizoidal Ditch
Side slopes = 2:1
Depth = 1.25 ft
Bottom Width = 2.0 ft
Riprap = 6 inch

Maximum Velocity = 6.97 fps
Maximum Depth = 0.61 ft
Freeboard = 0.64 ft

See pages 45 and 46 for calculation sheets and page 67 for a typical cross-section of the ditch

RD-2

Contributing Watershed is RWS-2

Peak Flow = 0.59 cfs
Minimum Slope = 1.77%
Maximum Slope = 17.24%

Trapizoidal Ditch
Side slopes = 2:1
Depth = 1.0 ft
Bottom Width = 1 ft
Riprap = none

Maximum Velocity = 4.07 fps
Maximum Depth = 0.27 ft
Freeboard = 0.73 ft

See pages 47 and 48 for calculation sheets and page 68 for a typical cross-section of the ditch

mod 1-06

RD-3

Contributing Watershed is RWS-3

Peak Flow = 1.47 cfs
Minimum Slope = 15.38%
Maximum Slope = 31.80%

Trapizoidal Ditch
Side slopes = 2:1
Depth = 1.0 ft
Bottom Width = 2.0 ft
Riprap = 3"

Maximum Velocity = 4.79 fps
Maximum Depth = 0.17 ft
Freeboard = 0.83 ft

See pages 49 and 50 for calculation sheets and page 69 for a typical cross-section of the ditch

RD-4

Contributing Watershed is RWS-4

Peak Flow = 0.50 cfs
Minimum Slope = 3.25%
Maximum Slope = 11.44%

Trapizoidal Ditch
Side slopes = 2:1
Depth = 1.0 ft
Bottom Width = 1.0 ft
Riprap = none

Maximum Velocity = 3.36 fps
Maximum Depth = 0.21 ft
Freeboard = 0.79 ft

See pages 51 and 52 for calculation sheets and page 70 for a typical cross-section of the ditch

RD-5

Contributing Watershed is RWS-5

Peak Flow = 6.87 cfs
Minimum Slope = 1.7 %
Maximum Slope = 2.4 %

Trapizoidal Ditch
Side slopes = 2:1
Depth = 1.0 ft
Bottom Width = 3.0 ft
Riprap = none

Maximum Velocity = 4.16 fps
Maximum Depth = 0.56 ft
Freeboard = 0.44 ft

See pages 53 and 54 for calculation sheets and page 71 for a typical cross-section of the ditch

Swale 1

Contributing Watershed is RWS-1

Peak Flow = 6.36 cfs
Slope = 3.6%

Trapizoidal Ditch
Side slopes = 4:1
Depth = 1.0 ft
Bottom Width = 3.0 ft
Riprap = none

Maximum Velocity = 4.66 fps
Maximum Depth = 0.44 ft
Freeboard = 0.56 ft

See page 55 for calculation sheets and page 72 for a typical cross-section of the ditch

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Summary of Watershed Data

Watershed Area	Drainage Area (ac)	Curve Number	S (in)	Y (%)	I (ft)	L (hr)	Time of Conc. (hr)	Peak Flow (cfs)
Operational Watersheds								
DWS-1	14.8	90	1.111	25.5	700	0.033	0.055	16.03
UWS-1	18	75	3.333	11	1500	0.154	0.257	4.74
UWS-2	25.5	75	3.333	18.4	1975	0.148	0.248	6.78
Reclamation Watersheds								
RWS-1	21.2	76	3.158	13.2	1500	0.136	0.228	6.55
RWS-2	1	80	2.500	20.3	260	0.024	0.040	0.59
RWS-3	2.6	80	2.500	21	510	0.040	0.068	1.47
RWS-4	0.87	80	2.500	19.9	330	0.029	0.049	0.5
RWS-5	26.1	75	3.333	18.4	2060	0.153	0.256	6.87

Notes

Watershed locations can be found on Plates RA7-1 and RA7-3
S = 1000/CN - 10
Y = average watershed slope = (length of contour lines)(contour interval)/(watershed area)
I = hydraulic length
L = watershed lag =(I^0.8(S+1)^0.7) / (1900(Y)^0.5)
Time of Concentration + 1.67L
Peak Flow is based on a 100-yr 6-hr storm event

Triangular Hydrograph Calculations using

SCSHYDRO Program

Watershed I.D.:
DWS-1 100-yr 6-hr

INPUT SUMMARY

STORM :	WATERSHED :
Dist.= SCS Type `b'	Area = 14.80 acres
Depth = 2.05 inches	CN = 90.00
Duration = 6.0 hrs	Time conc.= 0.06 hrs

OUTPUT SUMMARY

Runoff depth: 1.137 inches
Initial abstr: 0.222 inches
Peak flow: 16.03 cfs (1.074 iph)
at time: 2.508 hrs

Triangular Hydrograph Calculations using

SCSHYDRO Program

Watershed I.D.:
UWS-1 100-yr 6-hr

INPUT SUMMARY

STORM :	WATERSHED :
Dist.= SCS Type `b'	Area = 18.00 acres
Depth = 2.05 inches	CN = 75.00
Duration = 6.0 hrs	Time conc.= 0.26 hrs

OUTPUT SUMMARY

Runoff depth: 0.406 inches
Initial abstr: 0.667 inches
Peak flow: 4.74 cfs (0.261 iph)
at time: 2.639 hrs

Triangular Hydrograph Calculations using

SCSHYDRO Program

Watershed I.D.:
UWS-2

INPUT SUMMARY

STORM :	WATERSHED :
Dist.= SCS Type `b'	Area = 25.50 acres
Depth = 2.05 inches	CN = 75.00
Duration = 6.0 hrs	Time conc.= 0.25 hrs

OUTPUT SUMMARY

Runoff depth: 0.406 inches
Initial abstr: 0.667 inches
Peak flow: 6.78 cfs (0.264 iph)
at time: 2.612 hrs

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Triangular Hydrograph Calculations using

SCSHYDRO Program

Watershed I.D.:
RWS-1 100-YEAR 6-HOUR

INPUT SUMMARY

STORM :	WATERSHED :
Dist.= SCS Type `b'	Area = 21.20 acres
Depth = 2.05 inches	CN = 76.00
Duration = 6.0 hrs	Time conc.= 0.23 hrs

OUTPUT SUMMARY

Runoff depth: 0.440 inches
Initial abstr: 0.632 inches
Peak flow: 6.55 cfs (0.306 iph)
at time: 2.614 hrs

Triangular Hydrograph Calculations using

SCSHYDRO Program

Watershed I.D.:
RWS-2 100-YEAR 6-HOUR

INPUT SUMMARY

STORM :	WATERSHED :
Dist.= SCS Type `b'	Area = 1.00 acres
Depth = 2.05 inches	CN = 80.00
Duration = 6.0 hrs	Time conc.= 0.04 hrs

OUTPUT SUMMARY

Runoff depth:	0.593 inches
Initial abstr:	0.500 inches
Peak flow:	0.59 cfs (0.581 iph)
at time:	2.507 hrs

Triangular Hydrograph Calculations using

SCSHYDRO Program

Watershed I.D.:
RWS-3 100-YEAR 6-HOUR

INPUT SUMMARY

STORM :	WATERSHED :
Dist.= SCS Type `b'	Area = 2.60 acres
Depth = 2.05 inches	CN = 80.00
Duration = 6.0 hrs	Time conc.= 0.07 hrs

OUTPUT SUMMARY

Runoff depth: 0.593 inches
Initial abstr: 0.500 inches
Peak flow: 1.47 cfs (0.562 iph)
at time: 2.511 hrs

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mal 1-06

Triangular Hydrograph Calculations using

SCSHYDRO Program

Watershed I.D.:
RWS-4 100-YEAR 6-HOUR

INPUT SUMMARY

STORM :	WATERSHED :
Dist.= SCS Type `b'	Area = 0.87 acres
Depth = 2.05 inches	CN = 80.00
Duration = 6.0 hrs	Time conc.= 0.05 hrs

OUTPUT SUMMARY

Runoff depth: 0.593 inches
Initial abstr: 0.500 inches
Peak flow: 0.50 cfs (0.574 iph)
at time: 2.509 hrs

OCT 1 1 2006

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Triangular Hydrograph Calculations using

SCSHYDRO Program

Watershed I.D.:
RWS-5

INPUT SUMMARY

STORM :	WATERSHED :
Dist.= SCS Type `b'	Area = 26.10 acres
Depth = 2.05 inches	CN = 75.00
Duration = 6.0 hrs	Time conc.= 0.26 hrs

OUTPUT SUMMARY

Runoff depth: 0.406 inches
Initial abstr: 0.667 inches
Peak flow: 6.87 cfs (0.261 iph)
at time: 2.628 hrs

UD-1a Minimum Slope
Worksheet for Trapezoidal Channel

Project Description	
Worksheet	Dugout Refuse F
Flow Element	Trapezoidal Cha
Method	Manning's Formı
Solve For	Channel Depth

Input Data			
Mannings Coeffic	0.030		bare earth
Slope	.020000	ft/ft	
Left Side Slope	2.00	V : H	
Right Side Slope	2.00	V : H	
Bottom Width	1.00	ft	
Discharge	0.71	cfs	

Results			
Depth	0.27	ft	< 1' ∴ ok freeboard 0.73'
Flow Area	0.3	ft²	
Wetted Perim	1.60	ft	
Top Width	1.27	ft	
Critical Depth	0.24	ft	
Critical Slope	0.029060	ft/ft	
Velocity	2.32	ft/s	
Velocity Head	0.08	ft	
Specific Energ	0.35	ft	
Froude Numb	0.83		
Flow Type	Subcritical		

UD-1a Maximum Slope
Worksheet for Trapezoidal Channel

Project Description	
Worksheet	Dugout Refuse F
Flow Element	Trapezoidal Cha
Method	Manning's Formı
Solve For	Channel Depth

Input Data		
Mannings Coeffic	0.030	bare earth
Slope	0.150000	ft/ft
Left Side Slope	2.00	V : H
Right Side Slope	2.00	V : H
Bottom Width	1.00	ft
Discharge	0.71	cfs

Results		
Depth	0.14	ft
Flow Area	0.2	ft^2
Wetted Perimı	1.32	ft
Top Width	1.14	ft
Critical Depth	0.24	ft
Critical Slope	0.029060	ft/ft
Velocity	4.59	ft/s < 5fps ∴ no riprap
Velocity Head	0.33	ft
Specific Enerç	0.47	ft
Froude Numbı	2.20	
Flow Type	Supercritical	

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UD-1b Minimum Slope
Worksheet for Trapezoidal Channel

Project Description	
Worksheet	Dugout Refuse I
Flow Element	Trapezoidal Cha
Method	Manning's Formi
Solve For	Channel Depth

Input Data		
Mannings Coeffic	0.030	bare earth
Slope	0.003000	ft/ft
Left Side Slope	2.00	V : H
Right Side Slope	2.00	V : H
Bottom Width	2.00	ft
Discharge	3.79	cfs

Results		
Depth	0.87	ft < 1.5' ∴ ok freeboard = 0.63 ft
Flow Area	2.1	ft²
Wetted Perim	3.94	ft
Top Width	2.87	ft
Critical Depth	0.46	ft
Critical Slope	0.023150	ft/ft
Velocity	1.79	ft/s
Velocity Head	0.05	ft
Specific Energ	0.92	ft
Froude Numb	0.37	
Flow Type	Subcritical	

UD-1b Maximum Slope
Worksheet for Trapezoidal Channel

Project Description	
Worksheet	Dugout Refuse F
Flow Element	Trapezoidal Cha
Method	Manning's Formi
Solve For	Channel Depth

Input Data		
Mannings Coeffic	0.030	
Slope	0.028000	ft/ft
Left Side Slope	2.00	V : H
Right Side Slope	2.00	V : H
Bottom Width	2.00	ft
Discharge	3.79	cfs

Results		
Depth	0.44	ft
Flow Area	1.0	ft²
Wetted Perim	2.98	ft
Top Width	2.44	ft
Critical Depth	0.46	ft
Critical Slope	0.023150	ft/ft
Velocity	3.92	ft/s < 5 fps ∴ no riprap
Velocity Head	0.24	ft
Specific Energ	0.67	ft
Froude Numb	1.10	
Flow Type	Supercritical	

UD-1c Minimum Slope
Worksheet for Trapezoidal Channel

Project Description	
Worksheet	Dugout Refuse F
Flow Element	Trapezoidal Cha
Method	Manning's Formi
Solve For	Channel Depth

Input Data		
Mannings Coeffic	0.037	
Slope	044000	ft/ft
Left Side Slope	2.00	V : H
Right Side Slope	2.00	V : H
Bottom Width	2.00	ft
Discharge	4.74	cfs

$D_{50} = 6''$ Slope = 4.4%

Results		
Depth	0.50	ft
Flow Area	1.1	ft²
Wetted Perim	3.11	ft
Top Width	2.50	ft
Critical Depth	0.53	ft
Critical Slope	0.034748	ft/ft
Velocity	4.25	ft/s
Velocity Head	0.28	ft
Specific Energ	0.78	ft
Froude Numb	1.12	
Flow Type	Supercritical	

< 1.0 ft ∴ ok

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UD-1c Maximum Slope
Worksheet for Trapezoidal Channel

Project Description	
Worksheet	Dugout Refuse F
Flow Element	Trapezoidal Cha
Method	Manning's Formu
Solve For	Channel Depth

Input Data		
Mannings Coeffic	0.048	$D_{50} = 6''$ Slope = 23.3%
Slope	233000	ft/ft
Left Side Slope	2.00	V : H
Right Side Slope	2.00	V : H
Bottom Width	2.00	ft
Discharge	4.74	cfs

Results		
Depth	0.35	ft
Flow Area	0.8	ft²
Wetted Perim	2.78	ft
Top Width	2.35	ft
Critical Depth	0.53	ft
Critical Slope	0.058969	ft/ft
Velocity	6.26	ft/s < 7.5 fps ∴ ok
Velocity Head	0.61	ft
Specific Energ	0.96	ft
Froude Numb	1.94	
Flow Type	Supercritical	

DD-1 Min Slope
Worksheet for Trapezoidal Channel

Project Description	
Worksheet	Dugout Refuse F
Flow Element	Trapezoidal Cha
Method	Manning's Formı
Solve For	Channel Depth

Input Data			
Mannings Coeffic	0.035		rocky earth
Slope	006000	ft/ft	
Left Side Slope	2.00	V : H	
Right Side Slope	2.00	V : H	
Bottom Width	4.00	ft	
Discharge	11.22	cfs	

Results			
Depth	0.96	ft	< 1.5' ∴ ok freeboard = 0.54'
Flow Area	4.3	ft^2	
Wetted Perim	6.16	ft	
Top Width	4.96	ft	
Critical Depth	0.61	ft	
Critical Slope	0.026358	ft/ft	
Velocity	2.60	ft/s	
Velocity Head	0.10	ft	
Specific Enerç	1.07	ft	
Froude Numb	0.49		
Flow Type	Subcritical		

DD-1 Max Slope
Worksheet for Trapezoidal Channel

Project Description	
Worksheet	Dugout Refuse F
Flow Element	Trapezoidal Cha
Method	Manning's Formi
Solve For	Channel Depth

Input Data		
Mannings Coeffic	0.044	
Slope	129000	ft/ft
Left Side Slope	2.00	V : H
Right Side Slope	2.00	V : H
Bottom Width	4.00	ft
Discharge	11.22	cfs

$D_{50} = 6''$

Results		
Depth	0.43	ft
Flow Area	1.8	ft²
Wetted Perim	4.96	ft
Top Width	4.43	ft
Critical Depth	0.61	ft
Critical Slope	0.041091	ft/ft
Velocity	6.22	ft/s
Velocity Head	0.60	ft
Specific Energ	1.03	ft
Froude Numb	1.72	
Flow Type	Supercritical	

< 7.5 fps ∴ ok

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DD-1 Max Slope Not Requireing Riprap
Worksheet for Trapezoidal Channel

Project Description	
Worksheet	Dugout Refuse F
Flow Element	Trapezoidal Cha
Method	Manning's Formı
Solve For	Channel Depth

Input Data		
Mannings Coeffic	0.035	rocky soil
Slope	040000	ft/ft
Left Side Slope	2.00	V : H
Right Side Slope	2.00	V : H
Bottom Width	4.00	ft
Discharge	11.22	cfs

all channel sections with a slope greater than 4% will need $D_{50} = 6''$ riprap

Results		
Depth	0.54	ft
Flow Area	2.3	ft²
Wetted Perimı	5.20	ft
Top Width	4.54	ft
Critical Depth	0.61	ft
Critical Slope	0.026358	ft/ft
Velocity	4.91	ft/s < 5 fps
Velocity Head	0.37	ft
Specific Energ	0.91	ft
Froude Numbı	1.22	
Flow Type	;upercritical	

DD-2a Minimum Slope
Worksheet for Trapezoidal Channel

Project Description	
Worksheet	Dugout Refuse F
Flow Element	Trapezoidal Cha
Method	Manning's Formı
Solve For	Channel Depth

Input Data			
Mannings Coeffic	0.030		bare earth / coal refuse
Slope	019000	ft/ft	
Left Side Slope	2.00	V : H	
Right Side Slope	2.00	V : H	
Bottom Width	15.00	ft	
Discharge	8.02	cfs	

Results			
Depth	0.22	ft	< 2' ∴ ok
Flow Area	3.3	ft²	
Wetted Perim	15.49	ft	
Top Width	15.22	ft	
Critical Depth	0.21	ft	
Critical Slope	0.022733	ft/ft	
Velocity	2.43	ft/s	
Velocity Head	0.09	ft	
Specific Energ	0.31	ft	
Froude Numb	0.92		
Flow Type	Subcritical		

DD-2a Maximum Slope
Worksheet for Trapezoidal Channel

Project Description	
Worksheet	Dugout Refuse F
Flow Element	Trapezoidal Cha
Method	Manning's Form
Solve For	Channel Depth

Input Data		
Mannings Coeffic	0.030	bare earth / coal refuse
Slope	100000	ft/ft
Left Side Slope	2.00	V : H
Right Side Slope	2.00	V : H
Bottom Width	15.00	ft The ditch is also the access road for the sediment pond.
Discharge	8.02	cfs

Results		
Depth	0.13	ft
Flow Area	2.0	ft²
Wetted Perim	15.30	ft
Top Width	15.13	ft
Critical Depth	0.21	ft
Critical Slope	0.022733	ft/ft
Velocity	4.03	ft/s < 5.0 fps ∴ no riprap
Velocity Head	0.25	ft
Specific Energ	0.38	ft
Froude Numb	1.96	
Flow Type	Supercritical	

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DD-2b Minimum Slope
Worksheet for Trapezoidal Channel

Project Description	
Worksheet	Dugout Refuse I
Flow Element	Trapezoidal Cha
Method	Manning's Form
Solve For	Channel Depth

Input Data		
Mannings Coeffic	0.038	$D_{50} = 6''$ slope = 5%
Slope	050000	ft/ft
Left Side Slope	2.00	V : H
Right Side Slope	2.00	V : H
Bottom Width	4.00	ft
Discharge	8.02	cfs

Results		
Depth	0.43	ft < 1.0 ft ∴ ok
Flow Area	1.8	ft²
Wetted Perim	4.95	ft
Top Width	4.43	ft
Critical Depth	0.49	ft
Critical Slope	0.031690	ft/ft
Velocity	4.48	ft/s
Velocity Head	0.31	ft
Specific Enerç	0.74	ft
Froude Numb	1.24	
Flow Type	Supercritical	

DD-2b Maximum Slope
Worksheet for Trapezoidal Channel

Project Description	
Worksheet	Dugout Refuse F
Flow Element	Trapezoidal Cha
Method	Manning's Formi
Solve For	Channel Depth

Input Data		
Mannings Coeffic	0.044	$D_{50} = 6''$ slope = 13.5%
Slope	135000	ft/ft
Left Side Slope	2.00	V : H
Right Side Slope	2.00	V : H
Bottom Width	4.00	ft
Discharge	8.02	cfs

Results		
Depth	0.35	ft
Flow Area	1.4	ft²
Wetted Perim	4.77	ft
Top Width	4.35	ft
Critical Depth	0.49	ft
Critical Slope	0.043363	ft/ft
Velocity	5.57	ft/s < 7.5 fps ∴ ok
Velocity Head	0.48	ft
Specific Energ	0.83	ft
Froude Numb	1.71	
Flow Type	Supercritical	

DD-3a Minimum Slope
Worksheet for Trapezoidal Channel

Project Description	
Worksheet	Dugout Refuse F
Flow Element	Trapezoidal Cha
Method	Manning's Form
Solve For	Channel Depth

Input Data			
Mannings Coeffic	0.030		bare earth
Slope	013000	ft/ft	
Left Side Slope	2.00	V : H	
Right Side Slope	2.00	V : H	
Bottom Width	15.00	ft	
Discharge	16.03	cfs	

Results			
Depth	0.37	ft	< 1.0 ∴ ok
Flow Area	5.6	ft²	
Wetted Perim	15.83	ft	
Top Width	15.37	ft	
Critical Depth	0.33	ft	
Critical Slope	0.019771	ft/ft	
Velocity	2.84	ft/s	
Velocity Head	0.13	ft	
Specific Energ	0.50	ft	
Froude Numb	0.83		
Flow Type	Subcritical		

DD-3a Maximum Slope
Worksheet for Trapezoidal Channel

Project Description	
Worksheet	Dugout Refuse F
Flow Element	Trapezoidal Cha
Method	Manning's Formi
Solve For	Channel Depth

Input Data		
Mannings Coeffic	0.030	bare earth
Slope	035000	ft/ft
Left Side Slope	2.00	V : H
Right Side Slope	2.00	V : H
Bottom Width	15.00	ft
Discharge	16.03	cfs

Results		
Depth	0.28	ft
Flow Area	4.2	ft²
Wetted Perim	15.62	ft
Top Width	15.28	ft
Critical Depth	0.33	ft
Critical Slope	0.019771	ft/ft
Velocity	3.84	ft/s < 5.0 fps ∴ ok
Velocity Head	0.23	ft
Specific Enerç	0.51	ft
Froude Numb	1.30	
Flow Type	Supercritical	

DD-3b Minimum Slope
Worksheet for Trapezoidal Channel

Project Description	
Worksheet	Dugout Refuse F
Flow Element	Trapezoidal Cha
Method	Manning's Formi
Solve For	Channel Depth

Input Data		
Mannings Coeffic	0.037	
Slope	046000	ft/ft
Left Side Slope	2.00	V : H
Right Side Slope	2.00	V : H
Bottom Width	2.00	ft
Discharge	16.03	cfs

$D_{50} = 6''$ Slope = 4.6%

Results		
Depth	1.03	ft
Flow Area	2.6	ft²
Wetted Perim	4.31	ft
Top Width	3.03	ft
Critical Depth	1.14	ft
Critical Slope	0.033467	ft/ft
Velocity	6.15	ft/s
Velocity Head	0.59	ft
Specific Enerç	1.62	ft
Froude Numb	1.17	
Flow Type	Supercritical	

$< 1.5' \therefore$ ok

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DD-3b Maximum Slope
Worksheet for Trapezoidal Channel

Project Description	
Worksheet	Dugout Refuse F
Flow Element	Trapezoidal Cha
Method	Manning's Formi
Solve For	Channel Depth

Input Data		
Mannings Coeffic	0.041	
Slope	091000	ft/ft
Left Side Slope	2.00	V : H
Right Side Slope	2.00	V : H
Bottom Width	2.00	ft
Discharge	16.03	cfs

$D_{50} = 6''$ Slope = 9.1%

Results		
Depth	0.90	ft
Flow Area	2.2	ft²
Wetted Perim	4.01	ft
Top Width	2.90	ft
Critical Depth	1.14	ft
Critical Slope	0.041698	ft/ft
Velocity	7.28	ft/s
Velocity Head	0.82	ft
Specific Energ	1.72	ft
Froude Numb	1.47	
Flow Type	Supercritical	

< 7.5 fps ∴ ok

UC-1
Worksheet for Circular Channel

Project Description	
Worksheet	Dugout Refuse
Flow Element	Circular Channe
Method	Manning's Form
Solve For	Channel Depth

Input Data		
Mannings Coeffic	0.024	
Slope	045400	ft/ft
Diameter	24	in
Discharge	4.74	cfs

Results			
Depth	0.58	ft	< 2.0' ∴ ok
Flow Area	0.8	ft²	
Wetted Perime	2.27	ft	
Top Width	1.81	ft	
Critical Depth	0.77	ft	
Percent Full	28.9	%	
Critical Slope	0.015456	ft/ft	
Velocity	6.31	ft/s	> 5 fps ∴ riprap is needed
Velocity Head	0.62	ft	
Specific Energ	1.20	ft	
Froude Numbe	1.73		
Maximum Disc	28.08	cfs	
Discharge Full	26.11	cfs	
Slope Full	0.001496	ft/ft	
Flow Type	Supercritical		

UC-2
Worksheet for Circular Channel

Project Description	
Worksheet	Dugout Refuse
Flow Element	Circular Channe
Method	Manning's Forr
Solve For	Channel Depth

Input Data		
Mannings Coeffic	0.024	
Slope	015000	ft/ft
Diameter	24	in
Discharge	6.78	cfs

Results		
Depth	0.94	ft < 2' ∴ ok
Flow Area	1.5	ft²
Wetted Perime	3.03	ft
Top Width	2.00	ft
Critical Depth	0.92	ft
Percent Full	47.1	%
Critical Slope	0.016113	ft/ft
Velocity	4.66	ft/s < 5.0 fps ∴ no riprap
Velocity Head	0.34	ft
Specific Energ:	1.28	ft
Froude Numbe	0.96	
Maximum Disc	16.14	cfs
Discharge Full	15.01	cfs
Slope Full	0.003062	ft/ft
Flow Type	Subcritical	

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RD-1a Minimum Slope
Worksheet for Trapezoidal Channel

Project Description	
Worksheet	Refuse Pile Rec
Flow Element	Trapezoidal Cha
Method	Manning's Formı
Solve For	Channel Depth

Input Data		
Mannings Coeffic	0.035	Rocky Earth
Slope	048600	ft/ft
Left Side Slope	2.00	V : H
Right Side Slope	2.00	V : H
Bottom Width	1.00	ft
Discharge	0.98	cfs

Results		
Depth	0.27	ft < 1.0' ok
Flow Area	0.3	ft²
Wetted Perim	1.61	ft
Top Width	1.27	ft
Critical Depth	0.29	ft
Critical Slope	0.038867	ft/ft
Velocity	3.13	ft/s
Velocity Head	0.15	ft
Specific Energ	0.43	ft
Froude Numb	1.12	
Flow Type	Supercritical	

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RD-1a Maximum Slope
Worksheet for Trapezoidal Channel

Project Description	
Worksheet	Refuse Pile Rec
Flow Element	Trapezoidal Cha
Method	Manning's Formi
Solve For	Channel Depth

Input Data		
Mannings Coeffic	0.035	Rocky Earth
Slope	135900	ft/ft
Left Side Slope	2.00	V : H
Right Side Slope	2.00	V : H
Bottom Width	1.00	ft
Discharge	0.98	cfs

Results		
Depth	0.20	ft
Flow Area	0.2	ft²
Wetted Perim	1.45	ft
Top Width	1.20	ft
Critical Depth	0.29	ft
Critical Slope	0.038866	ft/ft
Velocity	4.46	ft/s < 5.0 fps ∴ ok
Velocity Head	0.31	ft
Specific Energ	0.51	ft
Froude Numb	1.84	
Flow Type	Supercritical	

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Project Engineer: Richard White

EarthFax Engineering Inc

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RD-1b Minimum Slope
Worksheet for Trapezoidal Channel

Project Description	
Worksheet	Refuse Pile Rec
Flow Element	Trapezoidal Cha
Method	Manning's Formı
Solve For	Channel Depth

Input Data		
Mannings Coeffic	0.030	bare ground
Slope	006800	ft/ft
Left Side Slope	2.00	V : H
Right Side Slope	2.00	V : H
Bottom Width	3.00	ft
Discharge	5.57	cfs

Results		
Depth	0.66	ft < 1.25' ok
Flow Area	2.2	ft²
Wetted Perimı	4.47	ft
Top Width	3.66	ft
Critical Depth	0.46	ft
Critical Slope	0.021275	ft/ft
Velocity	2.54	ft/s
Velocity Head	0.10	ft
Specific Enerç	0.76	ft
Froude Numbı	0.58	
Flow Type	Subcritical	

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mod 1-06

RD-1b Maximum Slope
Worksheet for Trapezoidal Channel

Project Description	
Worksheet	Refuse Pile Rec
Flow Element	Trapezoidal Cha
Method	Manning's Formı
Solve For	Channel Depth

Input Data		
Mannings Coeffic	0.030	bare ground
Slope	032400	ft/ft
Left Side Slope	2.00	V : H
Right Side Slope	2.00	V : H
Bottom Width	3.00	ft
Discharge	5.57	cfs

Results		
Depth	0.41	ft
Flow Area	1.3	ft^2
Wetted Perim	3.91	ft
Top Width	3.41	ft
Critical Depth	0.46	ft
Critical Slope	0.021275	ft/ft
Velocity	4.28	ft/s < 5.0 fps
Velocity Head	0.28	ft
Specific Energ	0.69	ft
Froude Numb	1.22	
Flow Type	Supercritical	

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RD-1c Minimum Slope
Worksheet for Trapezoidal Channel

Project Description	
Worksheet	Refuse Pile Rec
Flow Element	Trapezoidal Cha
Method	Manning's Form
Solve For	Channel Depth

Input Data		
Mannings Coeffic	0.037	$D_{50} = 6''$ slope = 4.4%
Slope	044000	ft/ft
Left Side Slope	2.00	V : H
Right Side Slope	2.00	V : H
Bottom Width	2.00	ft
Discharge	6.55	cfs

Results		
Depth	0.61	ft < 1.25
Flow Area	1.4	ft²
Wetted Perim	3.35	ft
Top Width	2.61	ft
Critical Depth	0.65	ft
Critical Slope	0.034226	ft/ft
Velocity	4.69	ft/s
Velocity Head	0.34	ft
Specific Energ	0.95	ft
Froude Numb	1.13	
Flow Type	Supercritical	

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mod 1-06

RD-1c Maximum Slope
Worksheet for Trapezoidal Channel

Project Description	
Worksheet	Refuse Pile Rec
Flow Element	Trapezoidal Cha
Method	Manning's Formı
Solve For	Channel Depth

Input Data			
Mannings Coeffic	0.048		$D_{50} = 6''$ slope = 23.3 %
Slope	0.233000	ft/ft	
Left Side Slope	2.00	V : H	
Right Side Slope	2.00	V : H	
Bottom Width	2.00	ft	
Discharge	6.55	cfs	

Results			
Depth	0.42	ft	
Flow Area	0.9	ft²	
Wetted Perim	2.95	ft	
Top Width	2.42	ft	
Critical Depth	0.65	ft	
Critical Slope	0.057602	ft/ft	
Velocity	6.97	ft/s	< 7.5 fps ∴ ok
Velocity Head	0.75	ft	
Specific Energ	1.18	ft	
Froude Numb	1.97		
Flow Type	Supercritical		

RD-2 Minimum Slope
Worksheet for Trapezoidal Channel

Project Description	
Worksheet	Refuse Pile Rec
Flow Element	Trapezoidal Cha
Method	Manning's Form
Solve For	Channel Depth

Input Data			
Mannings Coeffic	0.035		Rocky ground
Slope	017700	ft/ft	
Left Side Slope	2.00	V : H	
Right Side Slope	2.00	V : H	
Bottom Width	1.00	ft	
Discharge	0.59	cfs	

Results			
Depth	0.27	ft	< 1.0' ∴ ok
Flow Area	0.3	ft²	
Wetted Perim	1.61	ft	
Top Width	1.27	ft	
Critical Depth	0.21	ft	
Critical Slope	0.040045	ft/ft	
Velocity	1.89	ft/s	
Velocity Head	0.06	ft	
Specific Energ	0.33	ft	
Froude Numb	0.67		
Flow Type	Subcritical		

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mad 1-06

RD-2 Maximum Slope
Worksheet for Trapezoidal Channel

Project Description	
Worksheet	Refuse Pile Rec
Flow Element	Trapezoidal Cha
Method	Manning's Formı
Solve For	Channel Depth

Input Data		
Mannings Coeffic	0.035	Rocky ground
Slope	172400	ft/ft
Left Side Slope	2.00	V : H
Right Side Slope	2.00	V : H
Bottom Width	1.00	ft
Discharge	0.59	cfs

Results		
Depth	0.14	ft
Flow Area	0.1	ft^2
Wetted Perimı	1.30	ft
Top Width	1.14	ft
Critical Depth	0.21	ft
Critical Slope	0.040044	ft/ft
Velocity	4.07	ft/s < 5.0 fps ∴ ok
Velocity Head	0.26	ft
Specific Enerç	0.39	ft
Froude Numbı	2.01	
Flow Type	Supercritical	

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mal 1-06

RD-3 Minimum Slope
Worksheet for Trapezoidal Channel

Project Description	
Worksheet	Refuse Pile Rec
Flow Element	Trapezoidal Cha
Method	Manning's Formı
Solve For	Channel Depth

Input Data			
Mannings Coeffic	0.040		$D_{50} = 3''$ slope = 15.38
Slope	153800	ft/ft	
Left Side Slope	2.00	V : H	
Right Side Slope	2.00	V : H	
Bottom Width	2.00	ft	
Discharge	1.47	cfs	

Results			
Depth	0.17	ft	< 1.0' ∴ ok
Flow Area	0.4	ft²	
Wetted Perimı	2.38	ft	
Top Width	2.17	ft	
Critical Depth	0.25	ft	
Critical Slope	0.045437	ft/ft	
Velocity	4.09	ft/s	
Velocity Head	0.26	ft	
Specific Enerç	0.43	ft	
Froude Numbı	1.77		
Flow Type	Supercritical		

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mad 1-06

RD-3 Maximum Slope
Worksheet for Trapezoidal Channel

Project Description	
Worksheet	Refuse Pile Rec
Flow Element	Trapezoidal Cha
Method	Manning's Formı
Solve For	Channel Depth

Input Data		
Mannings Coeffic	0.045	D_{50} = 3"
Slope	318000	ft/ft
Left Side Slope	2.00	V : H
Right Side Slope	2.00	V : H
Bottom Width	2.00	ft
Discharge	1.47	cfs

slope = 31.8%

Results		
Depth	0.15	ft
Flow Area	0.3	ft²
Wetted Perim	2.33	ft
Top Width	2.15	ft
Critical Depth	0.25	ft
Critical Slope	0.057411	ft/ft
Velocity	4.79	ft/s
Velocity Head	0.36	ft
Specific Energ	0.50	ft
Froude Numb	2.23	
Flow Type	Supercritical	

< 5.0 fps ∴ ok

RD-4 Minimum Slope
Worksheet for Trapezoidal Channel

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mad 1-06

Project Description	
Worksheet	Refuse Pile Rec
Flow Element	Trapezoidal Cha
Method	Manning's Formi
Solve For	Channel Depth

Input Data		
Mannings Coeffic	0.035	Rocky Ground
Slope	032500	ft/ft
Left Side Slope	2.00	V : H
Right Side Slope	2.00	V : H
Bottom Width	1.00	ft
Discharge	0.50	cfs

Results		
Depth	0.21	ft < 1.0' ∴ ok
Flow Area	0.2	ft^2
Wetted Perim	1.46	ft
Top Width	1.21	ft
Critical Depth	0.19	ft
Critical Slope	0.040547	ft/ft
Velocity	2.21	ft/s
Velocity Head	0.08	ft
Specific Energ	0.28	ft
Froude Numb	0.90	
Flow Type	Subcritical	

RD-4 Maximum Slope
Worksheet for Trapezoidal Channel

Project Description	
Worksheet	Refuse Pile Rec
Flow Element	Trapezoidal Cha
Method	Manning's Formı
Solve For	Channel Depth

Input Data		
Mannings Coeffic	0.035	Rocky Ground
Slope	114400	ft/ft
Left Side Slope	2.00	V : H
Right Side Slope	2.00	V : H
Bottom Width	1.00	ft
Discharge	0.50	cfs

Results		
Depth	0.14	ft
Flow Area	0.1	ft²
Wetted Perim	1.31	ft
Top Width	1.14	ft
Critical Depth	0.19	ft
Critical Slope	0.040546	ft/ft
Velocity	3.36	ft/s < 5.0 fps ∴ ok
Velocity Head	0.18	ft
Specific Energ	0.31	ft
Froude Numb	1.64	
Flow Type	Supercritical	

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RD-5 Minimum Slope
Worksheet for Trapezoidal Channel

Project Description	
Worksheet	Refuse Pile Reclam
Flow Element	Trapezoidal Channe
Method	Manning's Formula
Solve For	Channel Depth

Input Data		
Mannings Coeffic	0.030	bare soil
Slope	017000	ft/ft
Left Side Slope	2.00	V : H
Right Side Slope	2.00	V : H
Bottom Width	3.00	ft
Discharge	6.87	cfs

Results		
Depth	0.56	ft < 1.0' ∴ ok
Flow Area	1.9	ft²
Wetted Perim	4.26	ft
Top Width	3.56	ft
Critical Depth	0.53	ft
Critical Slope	0.020872	ft/ft
Velocity	3.71	ft/s
Velocity Head	0.21	ft
Specific Energ	0.78	ft
Froude Numb	0.91	
Flow Type	Subcritical	

RD-5 Maximum Slope
Worksheet for Trapezoidal Channel

Project Description	
Worksheet	Refuse Pile Reclam
Flow Element	Trapezoidal Chann‹
Method	Manning's Formula
Solve For	Channel Depth

Input Data		
Mannings Coeffic	0.030	bare soil
Slope	024000	ft/ft
Left Side Slope	2.00	V : H
Right Side Slope	2.00	V : H
Bottom Width	3.00	ft
Discharge	6.87	cfs

Results		
Depth	0.51	ft
Flow Area	1.7	ft²
Wetted Perim‹	4.13	ft
Top Width	3.51	ft
Critical Depth	0.53	ft
Critical Slope	0.020871	ft/ft
Velocity	4.16	ft/s < 5.0 ∴ ok
Velocity Head	0.27	ft
Specific Energ	0.78	ft
Froude Numb‹	1.07	
Flow Type	Supercritical	

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Swale 1
Worksheet for Trapezoidal Channel

Project Description	
Worksheet	Refuse Pile Reclam
Flow Element	Trapezoidal Chann(
Method	Manning's Formula
Solve For	Channel Depth

Input Data			
Mannings Coeffic	0.030		bare soil
Slope	036000	ft/ft	
Left Side Slope	4.00	V : H	
Right Side Slope	4.00	V : H	
Bottom Width	3.00	ft	
Discharge	6.36	cfs	

Results			
Depth	0.44	ft	<1.0' ∴ ok
Flow Area	1.4	ft²	
Wetted Perim(	3.90	ft	
Top Width	3.22	ft	
Critical Depth	0.51	ft	
Critical Slope	0.022267	ft/ft	
Velocity	4.66	ft/s	< 5.0 fps ∴ ok
Velocity Head	0.34	ft	
Specific Energ	0.78	ft	
Froude Numb(	1.26		
Flow Type	Supercritical		

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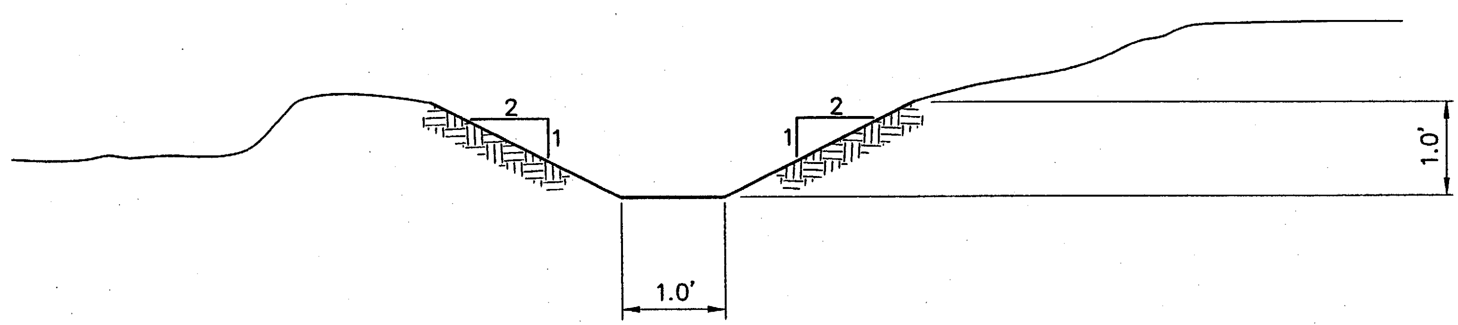

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UD-1a

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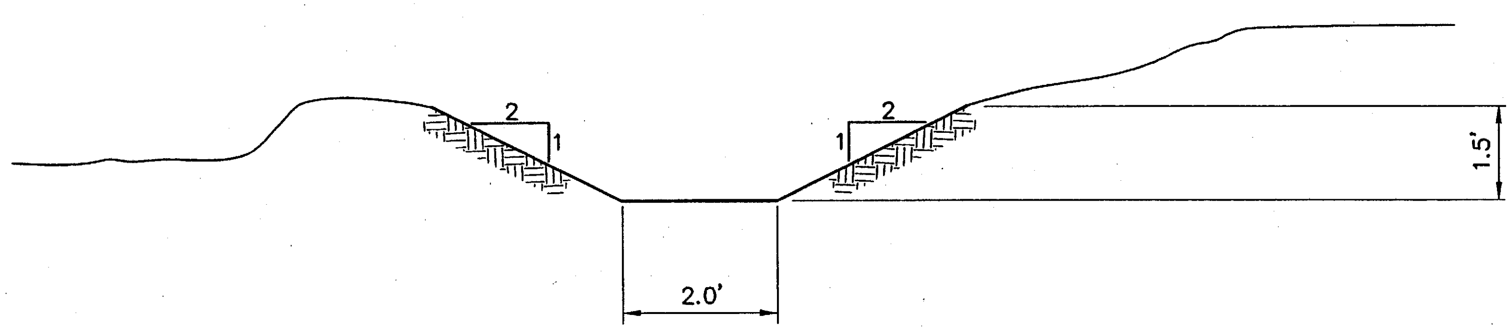

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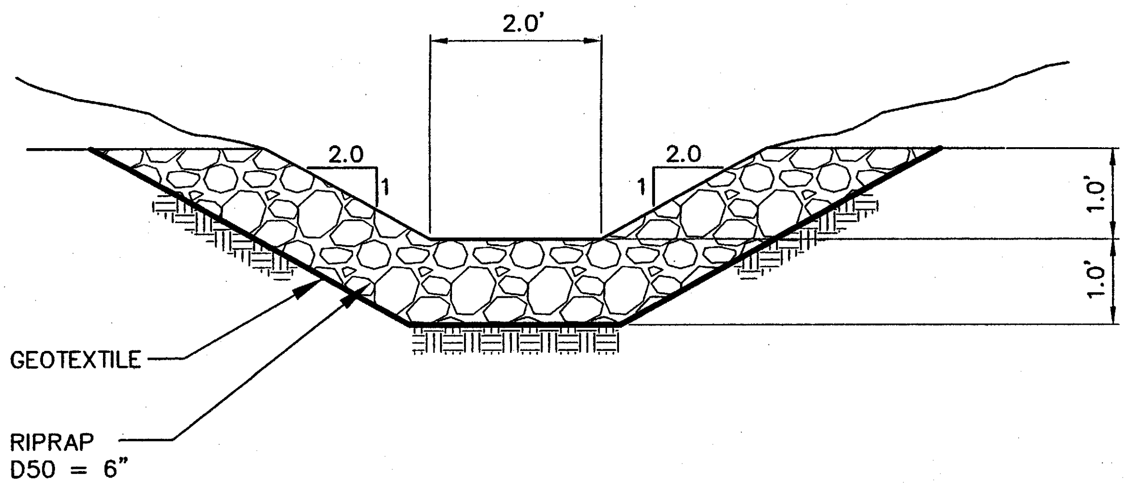

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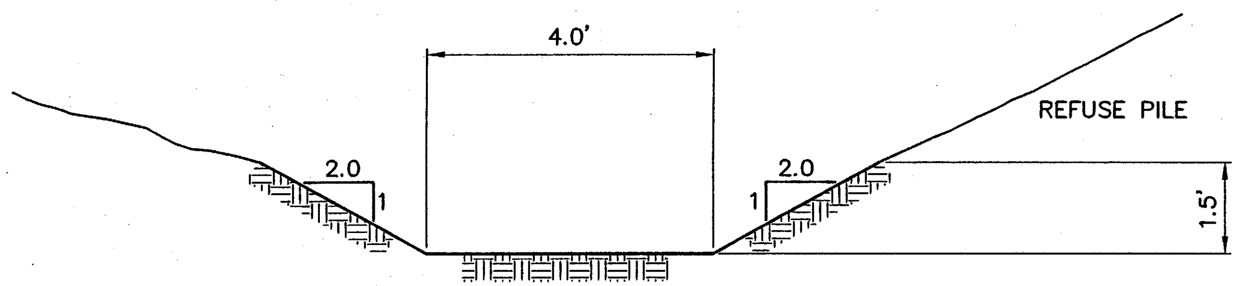

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DD-1 NON-RIPRAPPED SECTIONS (SLOPE UNDER 4%)

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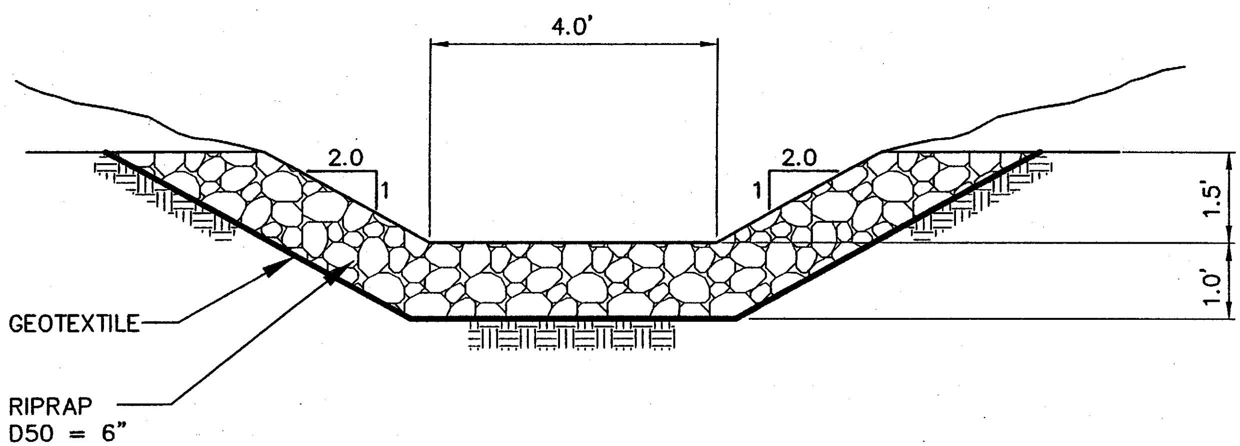

NO SCALE

DD-1 RIPRAPPED SECTIONS (SLOPE OVER 4%)

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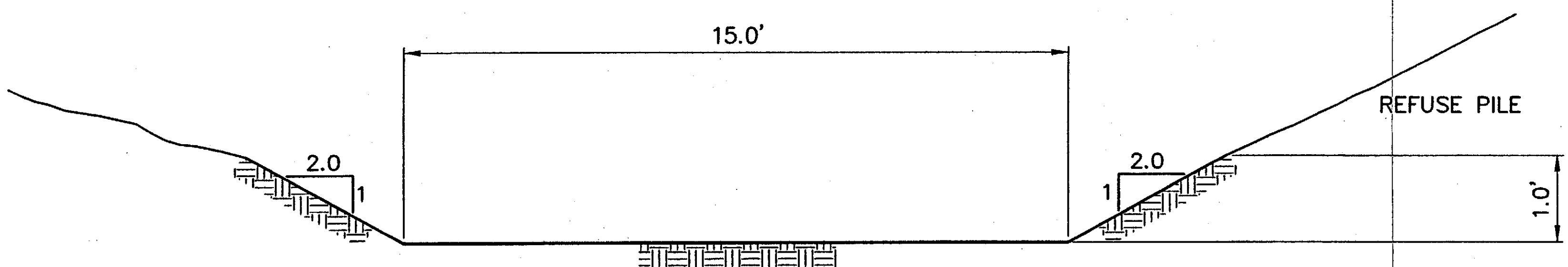

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DD-2a

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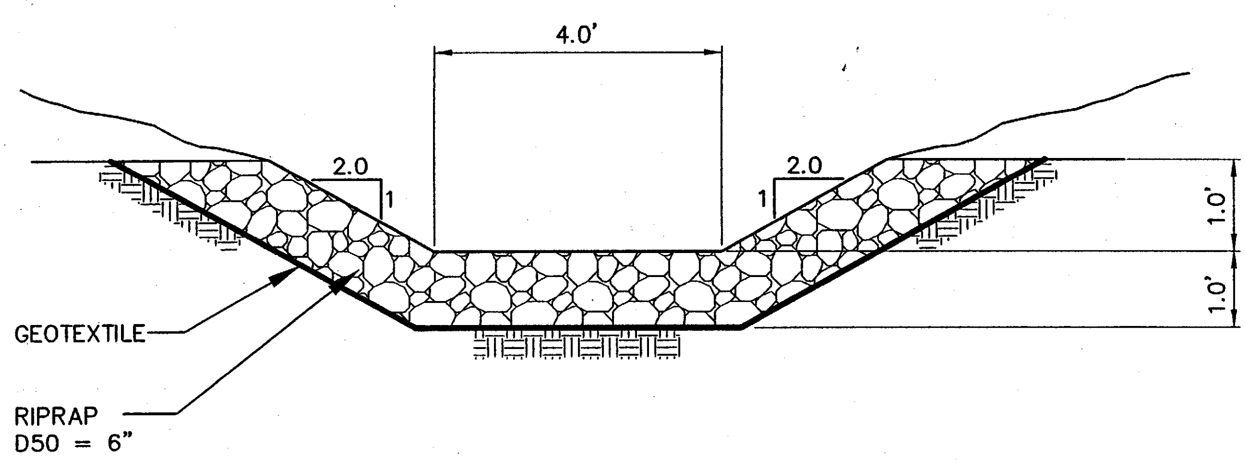

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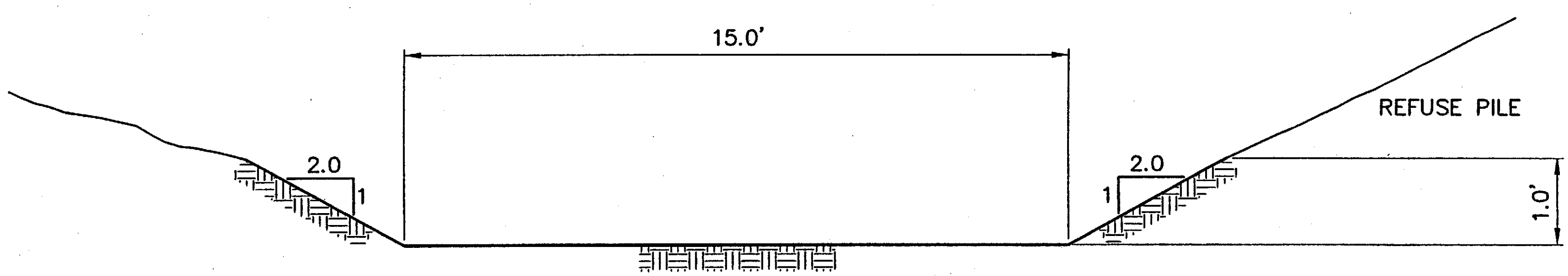

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DD-3a

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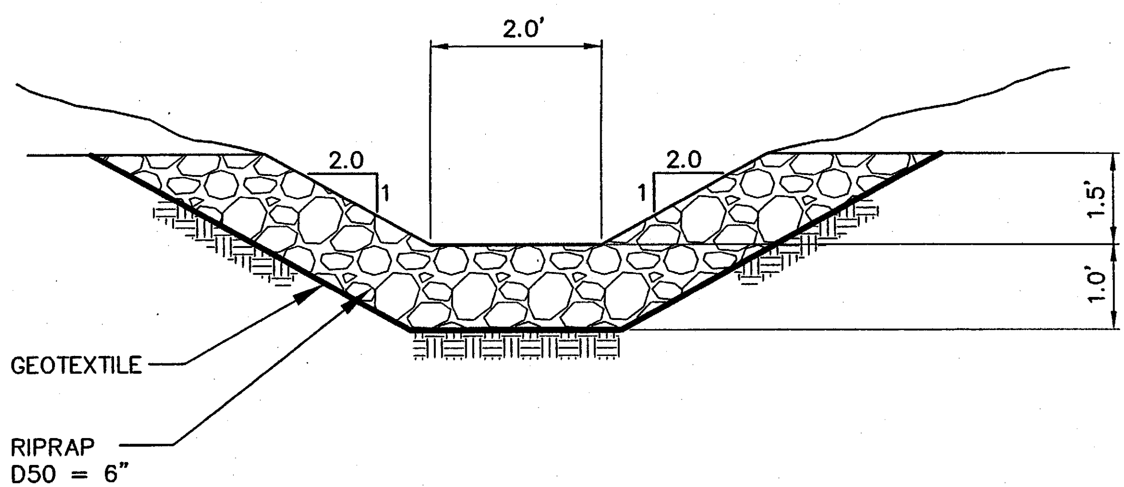

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DD–3b

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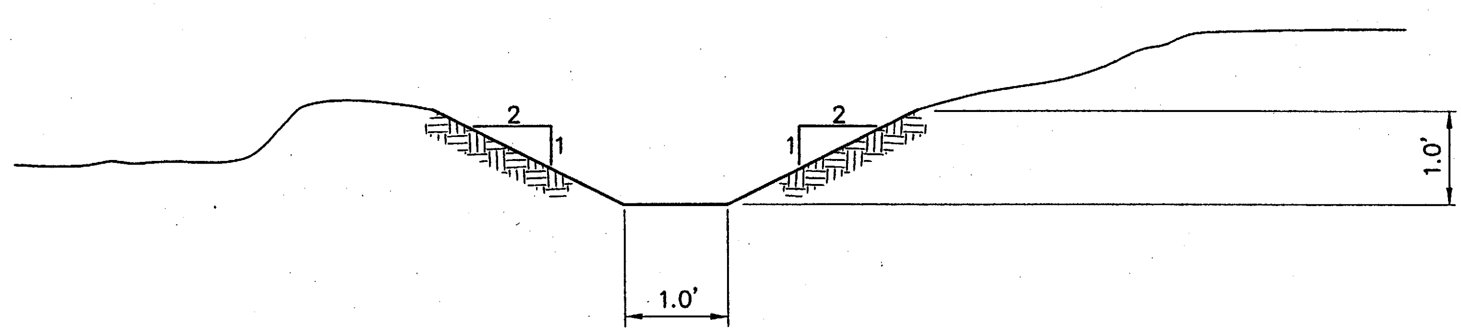

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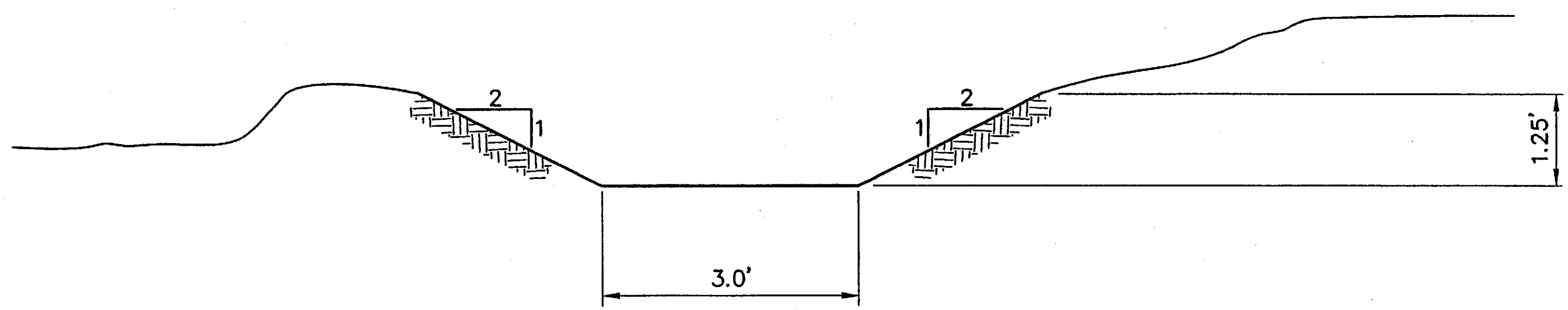

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RD-1b

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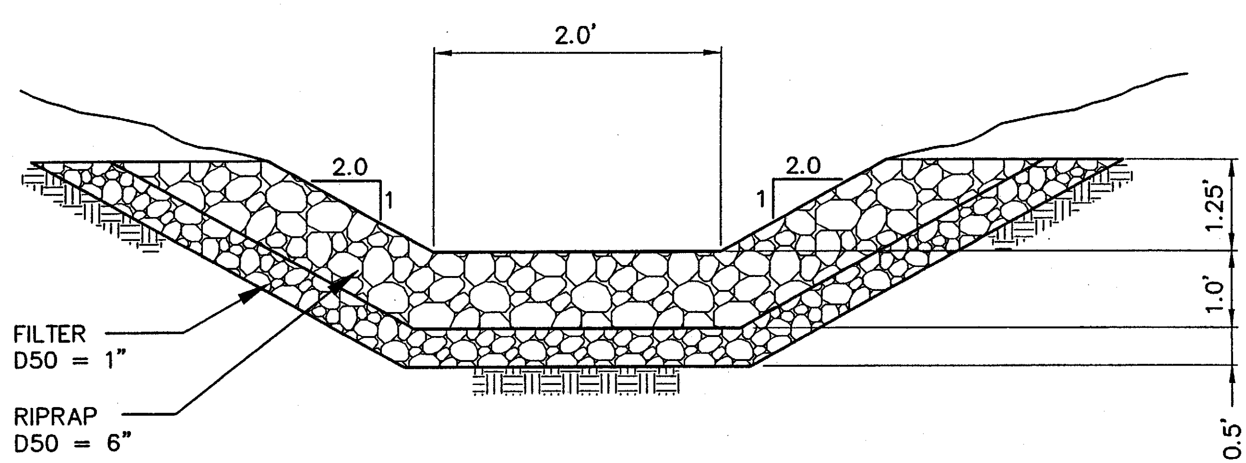

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RD–1c

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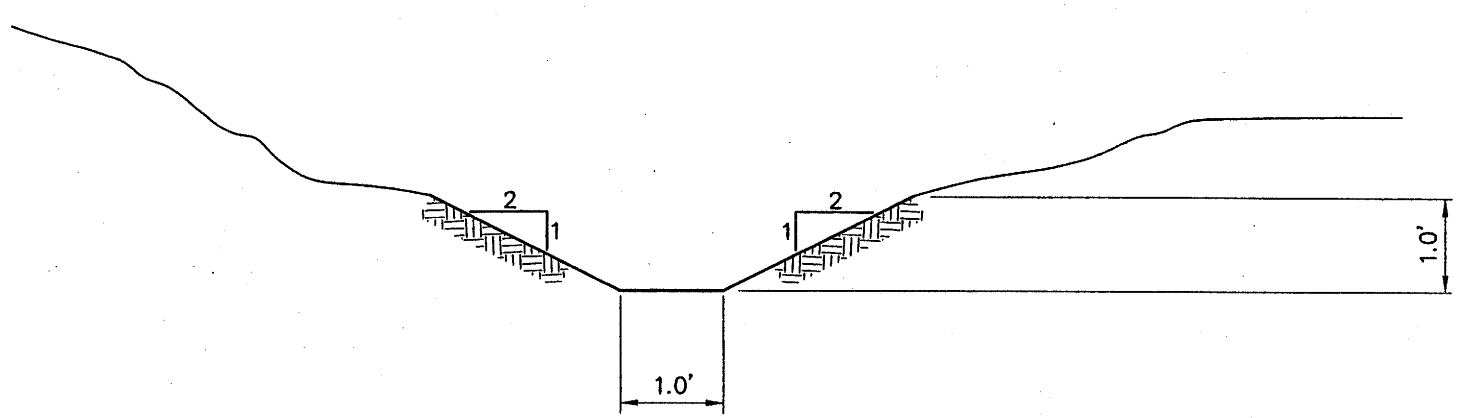

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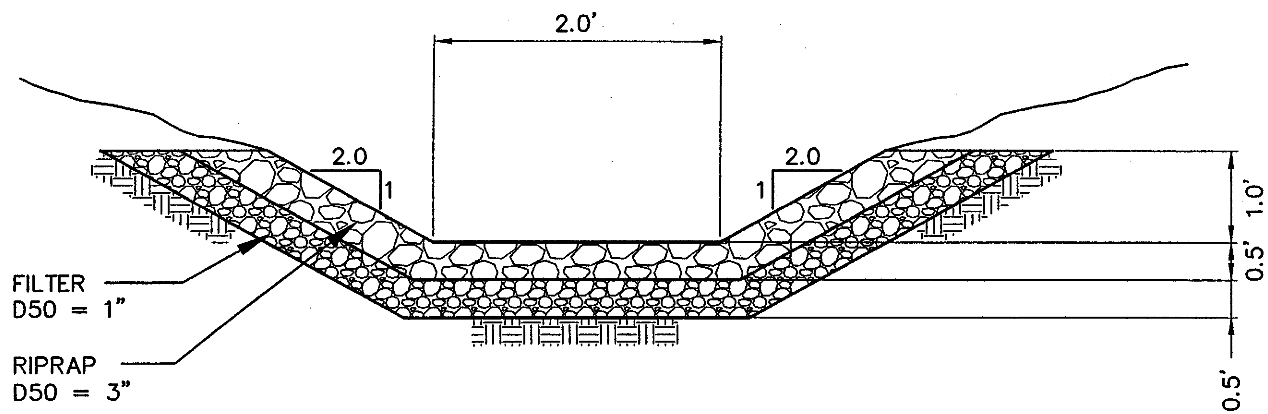

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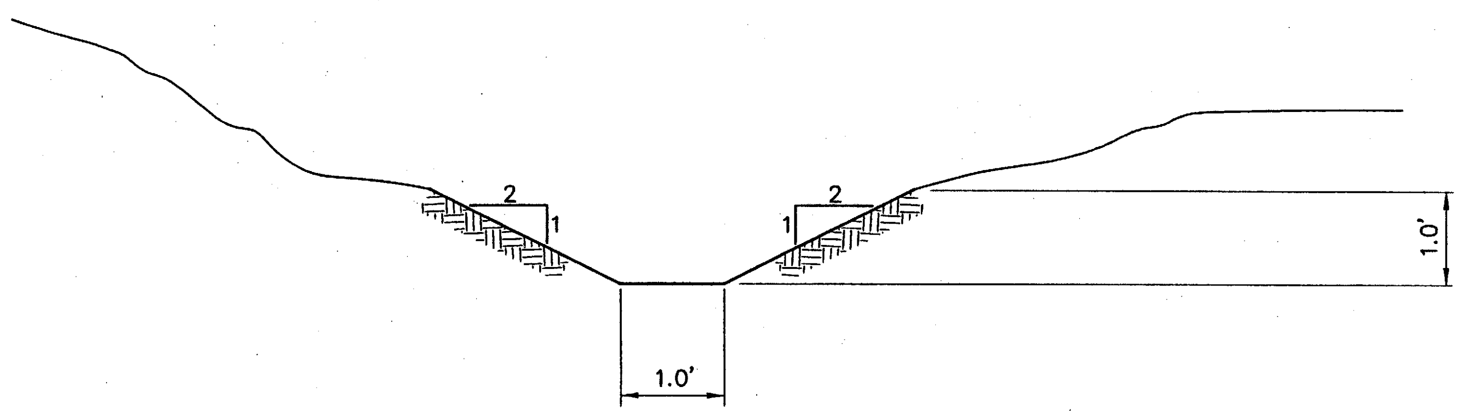

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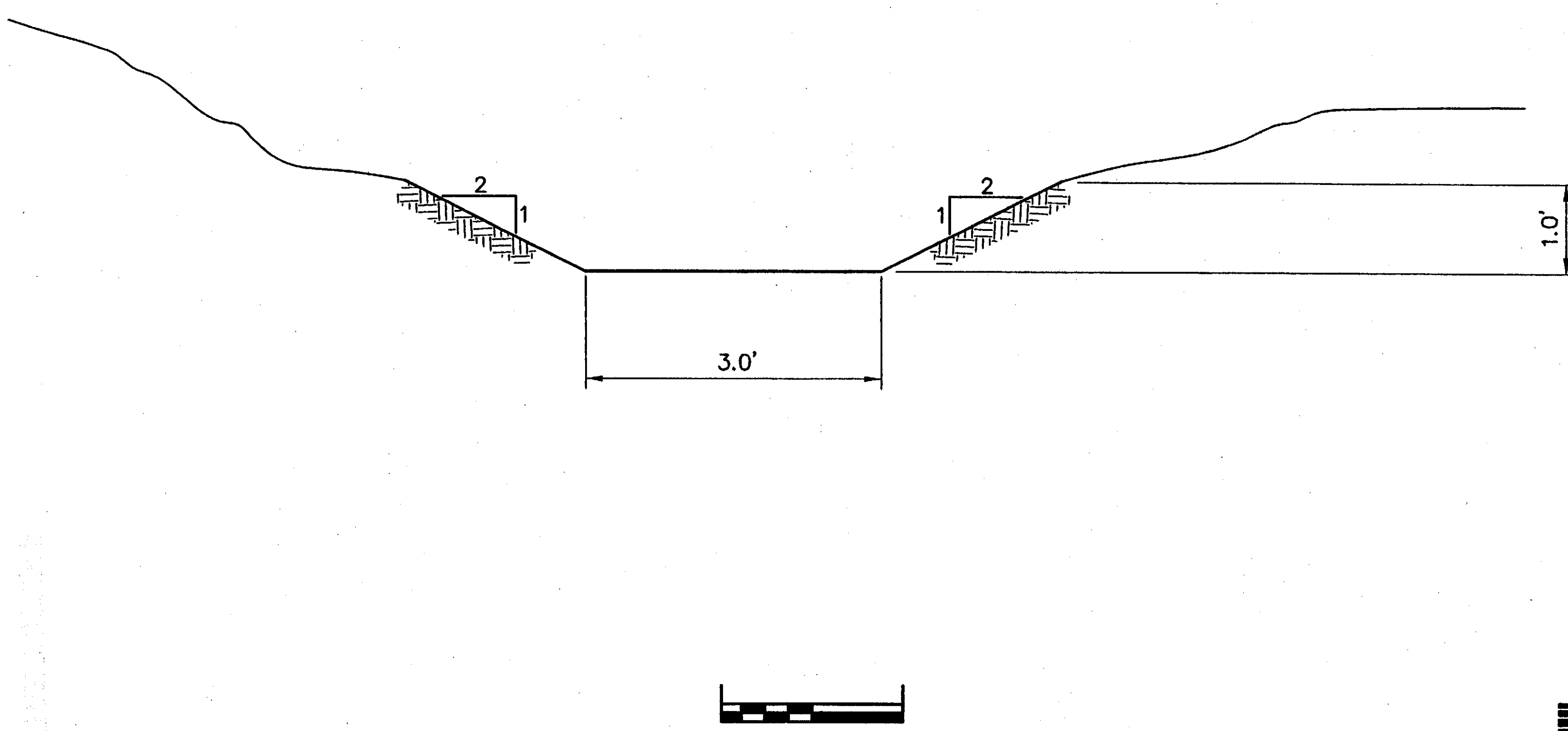

RD-5

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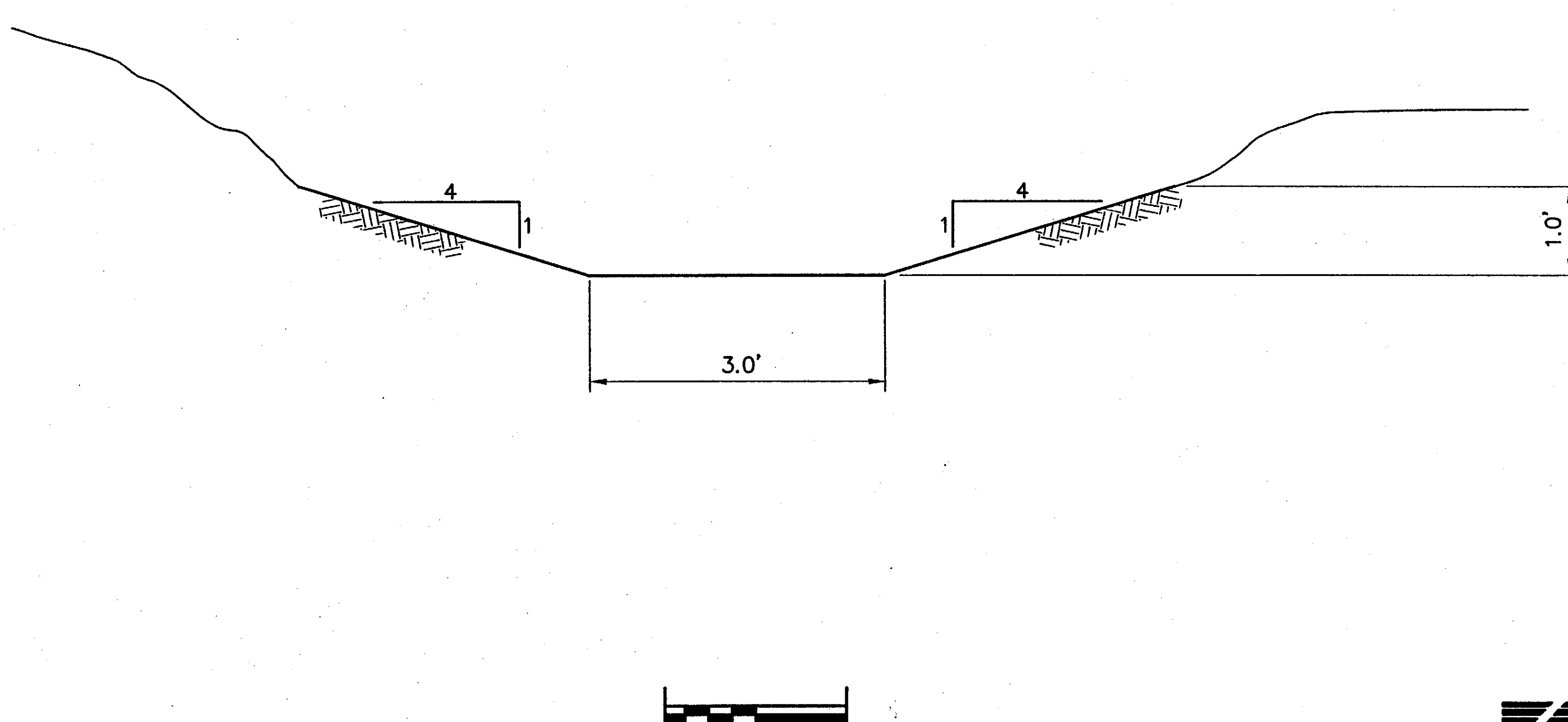

SWALE 1

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RA ATTACHMENT 7-5

CLIMATOLOGICAL INFORMATION

PRECIPITATION DATA - NOAA DATABASE

Annual Precipitation by Month

NUMBER	LOCATION	STATE	YEAR	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	OCT	NOV	DEC	ANN
427026	PRICE WAREHOUSES	UT	1968	00	00	00	00	00	00	00	182	29	49	0	96	356
427026	PRICE WAREHOUSES	UT	1969	250	137	24	28	37	241	146	183	59	38	33	10	1186
427026	PRICE WAREHOUSES	UT	1970	77	1	48	12	3	211	65	82	103	56	38	38	734
427026	PRICE WAREHOUSES	UT	1971	22	35	3	61	80	17	68	89	24	326	22	151	898
427026	PRICE WAREHOUSES	UT	1972	0	0	0	19	21	66	33	91	133	434	83	68	948
427026	PRICE WAREHOUSES	UT	1973	58	97	103	49	28	126	172	120	34	26	25	50	888
427026	PRICE WAREHOUSES	UT	1974	70	3	0	6	0	0	34	6	16	387	36	25	583
427026	PRICE WAREHOUSES	UT	1975	76	69	111	0	74	92	154	6	126	00	45	8	761
427026	PRICE WAREHOUSES	UT	1976	0	116	20	91	77	13	39	30	162	37	00	0	585
427026	PRICE WAREHOUSES	UT	1977	60	10	0	0	153	11	235	113	29	41	31	00	683
427026	PRICE WAREHOUSES	UT	1978	159	161	00	00	00	0	70	15	0	00	347	77	829
427026	PRICE WAREHOUSES	UT	1979	118	70	238	10	71	0	30	76	0	27	33	22	695
427026	PRICE WAREHOUSES	UT	1980	00	381	125	31	160	64	71	98	273	264	22	0	1489
427026	PRICE WAREHOUSES	UT	1981	11	21	195	86	54	16	22	162	126	343	9	42	1087
427026	PRICE WAREHOUSES	UT	1982	88	17	143	0	80	21	65	118	306	29	178	105	1150
427026	PRICE WAREHOUSES	UT	1983	93	126	142	51	101	58	185	118	155	65	228	39	1361
427026	PRICE WAREHOUSES	UT	1984	6	19	10	0	0	102	77	187	107	178	45	00	731
427026	PRICE WAREHOUSES	UT	1985	52	14	82	69	132	49	314	4	171	41	68	91	1087
427026	PRICE WAREHOUSES	UT	1986	15	185	69	119	37	10	112	93	199	142	00	0	981
427026	PRICE WAREHOUSES	UT	1987	70	150	200	33	154	74	228	161	15	00	00	150	1235
427026	PRICE WAREHOUSES	UT	1988	90	0	3	195	83	17	24	00	59	46	21	00	538
427026	PRICE WAREHOUSES	UT	1989	00	9	43	2	31	11	81	237	90	45	8	1	558
427026	PRICE WAREHOUSES	UT	1990	00	54	75	46	54	60	47	56	141	00	12	34	579
427026	PRICE WAREHOUSES	UT	1991	27	9	00	11	59	00	11	92	151	32	36	00	428
427026	PRICE WAREHOUSES	UT	1992	75	110	74	10	234	15	130	47	75	123	60	117	1070
427026	PRICE WAREHOUSES	UT	1993	00	195	154	30	51	40	1	136	21	190	43	12	873
427026	PRICE WAREHOUSES	UT	1994	0	120	6	192	0	10	15	155	119	220	00	52	889

427026	PRICE WAREHOUSES	UT	1995	103	17	00	147	183	153	69	200	98	00	00	00	970
427026	PRICE WAREHOUSES	UT	1996	73	32	146	33	158	45	34	2	227	109	126	41	1026
427026	PRICE WAREHOUSES	UT	1997	236	15	0	136	165	214	186	421	312	66	37	13	1801

NUMBER	LOCATION	STATE	YEAR	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	OCT	NOV	DEC	ANN
429368	WELLINGTON 3 E	UT	1980	00	00	00	00	00	1	56	153	300	135	10	2	657
429368	WELLINGTON 3 E	UT	1981	6	29	135	62	83	23	41	122	169	238	26	30	964
429368	WELLINGTON 3 E	UT	1982	96	13	138	0	36	4	32	121	186	25	159	82	892
429368	WELLINGTON 3 E	UT	1983	80	78	123	45	42	23	205	50	180	51	159	134	1170
429368	WELLINGTON 3 E	UT	1984	20	14	19	42	9	107	127	193	46	174	50	141	942
429368	WELLINGTON 3 E	UT	1985	33	4	73	107	114	39	159	0	225	39	130	40	963
429368	WELLINGTON 3 E	UT	1986	7	83	109	119	46	24	115	92	163	86	13	17	874
429368	WELLINGTON 3 E	UT	1987	41	72	121	74	94	52	223	164	1	177	132	77	1228
429368	WELLINGTON 3 E	UT	1988	112	0	27	214	42	40	9	44	59	53	00	51	651
429368	WELLINGTON 3 E	UT	1989	38	17	50	0	48	12	143	164	80	25	5	8	590
429368	WELLINGTON 3 E	UT	1990	27	55	80	54	49	48	120	33	264	27	3	33	793
429368	WELLINGTON 3 E	UT	1991	00	8	132	27	93	72	27	75	167	34	43	14	692
429368	WELLINGTON 3 E	UT	1992	00	132	91	12	216	21	148	73	82	156	38	116	1085
429368	WELLINGTON 3 E	UT	1993	153	165	143	36	141	25	27	52	14	143	00	14	913
429368	WELLINGTON 3 E	UT	1994	00	76	00	244	23	6	3	58	00	00	52	62	524
429368	WELLINGTON 3 E	UT	1995	88	36	80	190	269	102	92	199	43	0	22	18	1139
429368	WELLINGTON 3 E	UT	1996	65	00	97	13	148	20	29	26	318	112	140	20	988
429368	WELLINGTON 3 E	UT	1997	174	38	0	91	156	126	125	00	340	60	45	00	1155

Data is reported in hundredths of inches.
0 = No precipitation
00 = No data reported

Wellington 3 E = Latitude 39.32 Longitude -110.41 Elevation 5400
Price Warehouses = Latitude 39.617 Longitude -110.80 Elevation 5700

Climatological Information

Precipitation in the area of the refuse pile consists of occasional winter snow, with the average snow accumulation being between 12 and 18 inches and thunderstorms in July, August and September. Ground accumulations of snow are usually of short duration due to melting and wind.

According to the information from the Wellington weather station the majority of the precipitation is received in July through September. The Price Warehouses weather station reflects the majority of the precipitation occurring from July through October. Data from both stations has been provided because the elevation of the site ranges between 5850 and 5950 and the elevation of the Wellington station which is closest to the site is 5400 and the Price station is 5700.

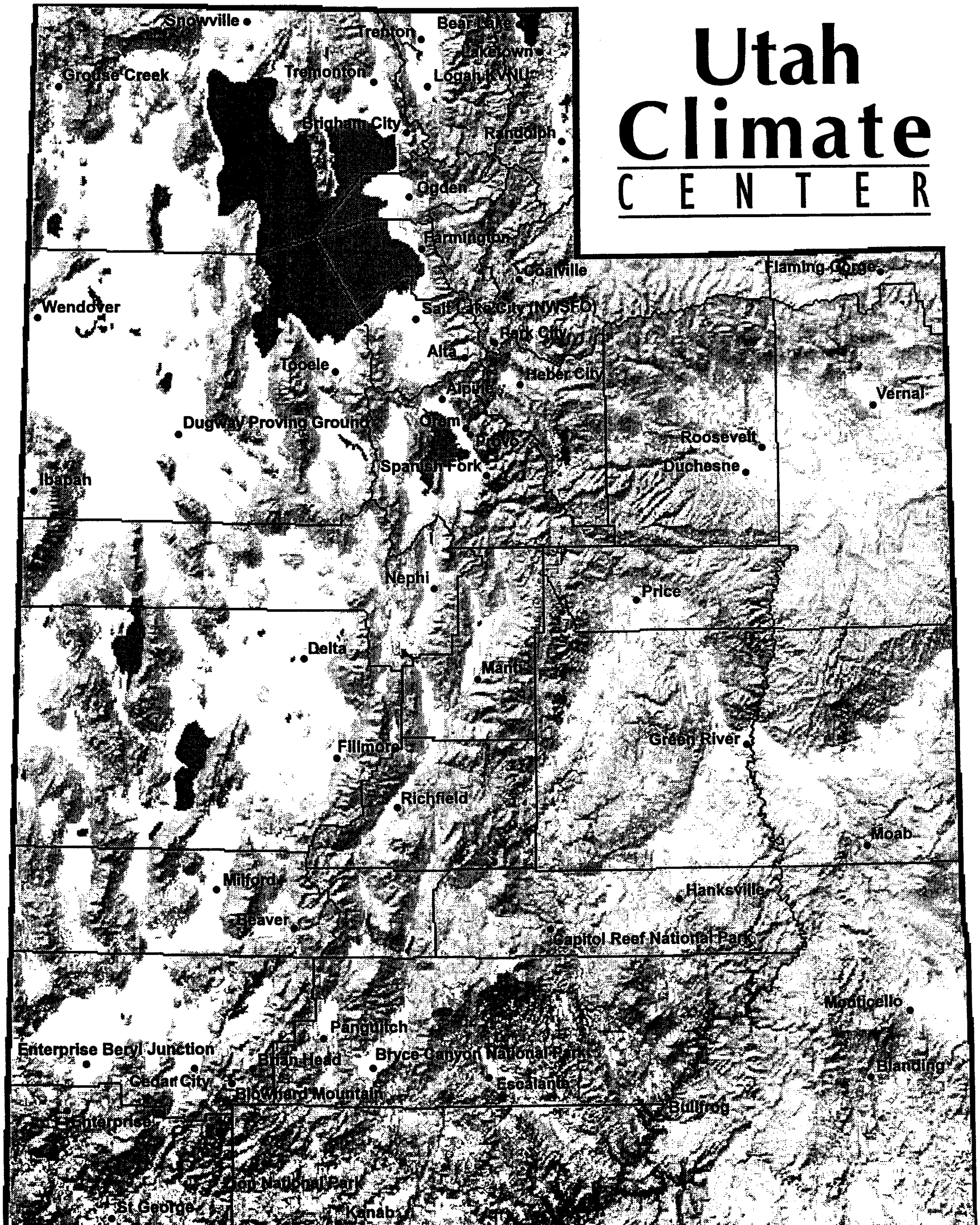
The Wellington station provided complete data for the years of 1981 through 1987, 1989 and 1990. The other years have monthly data missing. The average annual precipitation for 1981 through 1987 (7 year period)was 10 inches. With 1987 and 1983 receiving the highest annual precipitation of approximately 12 inches. The average annual precipitation for 1989 through 1990 was much lower at 7 inches. During 1981 through 1985 (5 year period) the majority of the precipitation fell in March and July through December. In the years 1989 through 1990 the majority of the precipitation fell in March, July, August and September.

The Price station provided complete data for at least two consecutive years for 1969 through 1974, 1981 through 1983 and 1996 through 1997. The other years have monthly data missing. The average annual precipitation for 1969 through 1974 (6 year period) was 9 inches. With 1969 receiving 12 inches (greatest) of precipitation and 1974 receiving only 6 inches. The average annual precipitation for 1981 through 1983 was 12 inches and 1996 through 1997 was 14 inches. During 1969 through 1974 the majority of the precipitation fell in June through October. In the years 1996 through 1997 the majority of the precipitation fell in January, May, June, August and September.

Temperature information was collected from the Utah Climate Center, Price Warehouses location (data sheets follow). Average summer temperatures for June through August range from 51 to 90 degrees. Average winter temperatures for November through February range from 13 to 49 degrees. The period of record for the range of temperatures is 1986 through 1995.

Map of Utah Climate Locations

Utah Climate CENTER



Page 4

Location: Price Warehouses County: Carbon Latitude: 39.617 Longitude: -110.800
Elevation: 5700 feet Period of Record: 1968-1995

PRICE WAREHOUSES

Monthly Data Summary

Maximum Temperature in °F

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Annual
Monthly normal													
Standard deviation													
Average monthly	36.9	42.7	52.7	63.1	72.5	83.8	90.0	88.4	79.5	65.1	49.5	39.9	63.7
Standard deviation	8.2	8.7	8.6	9.2	8.7	8.4	5.1	5.6	7.6	10.2	8.8	7.8	8.1
High monthly average	47.8	50.7	63.0	71.5	79.7	91.3	93.4	91.6	88.1	72.6	55.4	50.6	93.4
Year of occurrence	1981	1977	1972	1992	1974	1974	1988	1971	1974	1988	1976	1980	1988
Low monthly average	27.3	34.8	45.5	55.0	66.5	75.4	86.1	84.5	73.4	57.2	43.3	30.4	27.3
Year of occurrence	1979	1979	1969	1983	1980	1975	1983	1979	1985	1984	1985	1978	1979
Record high daily	62	68†	75	84†	91	101	107	100†	95†	86	69†	59†	107
Day of occurrence	31	23	26	30	28	27	26	9	15	5	4	25	26
Year of occurrence	1971	1995	1971	1992	1983	1994	1978	1990	1990	1979	1988	1980	1978
Record low daily	11†	13	28	37†	46	52	71	68	47	31	26	9	9
Day of occurrence	7	1	2	28	8	20	27	15	29	30	25	24	24
Year of occurrence	1971	1985	1971	1994	1986	1975	1983	1979	1982	1991	1993	1990	1990
Days w/max >= 100	0.0	0.0	0.0	0.0	0.0	0.0	0.3	0.1	0.0	0.0	0.0	0.0	0.4
Days w/max >= 90	0.0	0.0	0.0	0.0	0.1	7.8	18.4	14.2	1.9	0.0	0.0	0.0	42.8
Days w/max <= 32	8.8	2.1	0.1	0.0	0.0	0.0	0.0	0.0	0.0	0.1	0.6	5.5	18.4

Minimum Temperature in °F

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Annual
Monthly normal													
Standard deviation													
Average monthly	13.4	19.7	27.7	34.5	42.9	51.7	58.3	57.0	48.2	37.6	25.9	16.4	36.1
Standard deviation	9.2	8.9	6.7	7.3	6.6	7.3	5.4	5.2	6.9	7.6	7.5	8.2	7.2
High monthly average	22.8	28.9	34.2	43.1	47.8	57.1	62.7	60.4	53.5	42.7	30.7	24.2	62.7
Year of occurrence	1981	1986	1986	1992	1992	1974	1974	1994	1979	1972	1976	1977	1974
Low monthly average	4.4	9.8	20.5	28.4†	37.6	44.4	54.0	53.8	42.1	31.4	19.8	8.9	4.4
Year of occurrence	1973	1974	1969	1974	1975	1975	1993	1990	1986	1986	1993	1972	1973
Record high daily	34	46	48	55†	61	74	74	74†	67	57	50	41	74†
Day of occurrence	14	24	17	28	9	29	17	10	5	6	1	3	10
Year of occurrence	1980	1986	1972	1992	1989	1974	1978	1969	1974	1979	1987	1977	1969
Record low daily	-15	-10	4	8	21	28	38†	34†	24†	4	4	-14	-15
Day of occurrence	7	1	2	8	10	14	6	19	30	30	26	24	7
Year of occurrence	1971	1985	1971	1980	1986	1976	1982	1980	1986	1971	1993	1990	1971
Days w/min <= 32	30.7	26.5	23.5	11.3	2.1	0.1	0.0	0.0	0.7	7.8	23.9	30.0	163.1
Days w/min <= 0	2.9	0.8	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	1.1	5.2
Days w/min <= -20	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0

Mean Temperature in °F

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Annual
Monthly normal													
Standard deviation													
Average monthly	25.1	31.2	40.1	48.8	57.7	67.8	74.2	72.7	63.8	51.2	37.7	28.2	49.9
Standard deviation	8.0	8.1	6.8	7.6	7.0	7.3	4.5	4.8	6.6	8.2	7.5	7.2	7.0
High monthly average	35.3	39.3	47.6	57.3	62.3	74.2	78.0	75.9	69.4	57.4	44.5	37.2	78.0
Year of occurrence	1981	1986	1986	1992	1992	1974	1974	1994	1979	1988	1976	1980	1974
Low monthly average	16.6	22.3	33.0	43.0	53.5	60.4	70.9	70.0	58.9	45.2	32.8	19.8	16.6
Year of occurrence	1979	1979	1969	1970	1975	1975	1993	1979	1985	1969	1993	1978	1979

† Also occurred on earlier date(s).

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PRICE WAREHOUSES

Monthly Data Summary

Precipitation in Inches

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Annual
Monthly normal													
Standard deviation													
Average monthly	0.80	0.79	0.81	0.50	0.73	0.55	0.93	0.98	1.01	1.23	0.61	0.56	9.49
Standard deviation	0.09	0.12	0.10	0.08	0.09	0.09	0.11	0.11	0.14	0.16	0.09	0.08	0.11
High monthly total	2.57	3.81	2.38	1.95	2.34	2.41	3.14	2.00	3.06	4.34	3.47	1.51	4.34
Year of occurrence	1980	1980	1979	1988	1992	1969	1985	1995	1982	1972	1978	1971	1972
Low monthly total	0.00†	0.00†	0.00†	0.00†	0.00†	0.00†	0.01	0.04	0.00†	0.00	0.00†	0.00†	0.00†
Year of occurrence	1994	1988	1977	1984	1994	1979	1993	1985	1979	1975	1976	1986	1986
Record high daily	0.76	1.60	1.50	1.15	0.92	1.27	0.93	2.16	1.70	1.66	1.20	0.88	2.16
Day of occurrence	4	18	9	18	21	10	15	21	24	15	21	7	21
Year of occurrence	1982	1980	1987	1988	1987	1970	1973	1989	1986	1980	1983	1987	1989
Days w/pcp >= .01	4.2	3.7	4.5	3.2	4.4	3.3	5.5	5.8	4.9	4.4	3.3	3.8	51.3
Days w/pcp >= .10	2.7	2.2	2.5	1.3	2.2	1.5	2.5	3.0	2.6	2.7	1.8	1.8	27.0
Days w/pcp >= .50	0.3	0.4	0.3	0.2	0.3	0.3	0.6	0.5	0.5	0.8	0.4	0.2	4.9

Snow and Sleet in Inches

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Annual
Monthly normal													
Standard deviation													
Average monthly	8.7	4.8	1.2	0.3	0.0	0.0	0.0	0.0	0.0	0.3	2.4	6.0	23.7
Standard deviation	1.1	0.7	0.3	0.2	0.0	0.0	0.0	0.0	0.0	0.1	0.5	0.9	0.3
High monthly total	30.7	19.7	8.6	6.0	1.0	0.0†	0.0†	0.0†	0.0†	3.5	7.8	20.5	30.7
Year of occurrence	1978	1978	1975	1973	1979	1995	1995	1995	1995	1971	1994	1984	1978
Low monthly total	0.0†	0.0†	0.0†	0.0†	0.0†	0.0†	0.0†	0.0†	0.0†	0.0†	0.0†	0.0†	0.0†
Year of occurrence	1994	1995	1995	1995	1995	1995	1995	1995	1995	1994	1990	1989	1989
Record high daily	13.0	8.4	4.0	4.0	1.0	0.0†	0.0†	0.0†	0.0†	2.0	6.5	13.0	13.0†
Day of occurrence	19	10	24	1	7	30	31	31	30	29	25	20	20
Year of occurrence	1988	1978	1983	1973	1979	1995	1995	1995	1995	1971	1983	1984	1984
Days w/snow >= .1	3.9	2.5	0.9	0.2	0.0	0.0	0.0	0.0	0.0	0.3	1.2	2.7	11.3
Days w/snow >= 5	0.4	0.2	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.1	0.2	0.9
Days w/snow >= 10	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.1

Degree Days

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Annual
Heating normal													
Heating average	1227	936	749	479	236	55	2	4	94	417	809	1119	6132
Cooling normal													
Cooling average	0	0	0	0	13	139	285	241	59	2	0	0	742
Growing 40 normal													
Growing 40 average	29	68	193	353	540	708	855	828	641	397	151	47	4814
Growing 50 normal													
Growing 50 average	3	15	72	199	349	528	676	644	451	232	49	3	3229

† Also occurred on earlier date(s).

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Canyon Fuel Company, LLC
Dugout Canyon Mine

Refuse Pile Amendment
February 13, 2003

RA ATTACHMENT 7-6

SOLDIER CANYON MINE, PLATE 7-1

CHAPTER 8

BONDING AND INSURANCE

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CHAPTER 8
BONDING AND INSURANCE

810 BONDING DEFINITIONS AND DIVISION RESPONSIBILITIES

This chapter provides information regarding the bonding for coal mining and reclamation operations at the Dugout Canyon Mine Refuse Pile. CFC will have on file with the Division a bond or bonds made payable to the Division for performance of all the requirements of the State Program.

820 REQUIREMENT TO FILE A BOND

The disturbed area (15.60 acres) covered by the bond is outlined on RA Plate 5-1 of this amendment. The disturbed area and specific acres to be reclaimed are discussed in Section 340. The performance bond period is for the duration of the coal mining and reclamation operations including the extended period designated by the Division. The bond is in the form of a surety bond and is described in Section 860 of the M&RP.

830 DETERMINATION OF BOND AMOUNT

The reclamation bond (direct and indirect costs) for the Dugout Canyon Mine refuse pile site is found in Appendix 5-6 of the M&RP. The most current formulas from the Office of Surface Mining, *Handbook for Calculation of Reclamation Bond Amounts*, were used to determine the coverage necessary for reclamation (Means, 2006). Additional details concerning the estimate can be found in Sections 540, and 550 of this amendment. The bond coverage will be adjusted per the Division's determination of required bond coverage.

840 GENERAL TERMS AND CONDITIONS OF THE BOND

Refer to Chapter 8 of the approved M&RP.

850 BONDING REQUIREMENTS FOR UNDERGROUND COAL MINING AND RECLAMATION ACTIVITIES

Refer to Chapter 8 of the approved M&RP.

860 FORMS OF BONDS

Refer to Chapter 8 of the approved M&RP.

870 REPLACEMENT OF BONDS

Refer to Chapter 8 of the approved M&RP.

880 REQUIREMENTS TO RELEASE PERFORMANCE BONDS

The applicant will comply with the requirements described in Section R645-301-880 of the Division regulations when applying for the release of performance bonds.

890 TERMS AND CONDITIONS FOR LIABILITY INSURANCE

Certificates of Insurance issued for the Dugout Mine are included as Appendix 1-2 of the M&RP. For additional information refer to Chapter 8 of the approved M&RP.

RA ATTACHMENT 8-1

REFUSE PILE BOND CALCULATIONS

Direct Costs

Subtotal Demolition and Removal	$644,994	
Subtotal Backfilling and Grading	$628,346	
Subtotal Revegetation	$197,099	
Subtotal Direct Costs	$1,470,438	
Indirect Costs		
Mobilization/Demobilization	$147,044	10.00%
Contingencies	$73,522	5.00%
Engineering Redesign	$36,761	2.50%
Main Office Expense	$99,990	6.80%
Project Management Fee	$36,761	2.50%
Subtotal Indirect Costs	$394,077	
Total Costs	$1,864,515	
Inflation Factor		0.025226
Years		5
Inflation	$235,176	
Reclamation Cost Inflated	$2,099,691	
Bond Amount (rounded to nearest $1,000)	$2,100,000	

Inflation Factor = $\frac{\text{ENR Construction Cost Index (CCI) for Current Year}}{\text{ENR CCI for mo/yr 5 years prior to Current Year}}$

Current Year Sept. 2002	6589 =	1.126132
Prior Sept. 1997	5851	12.61%

Materials	Reference Number	Cost	Unit
Excavate Broken Concrete 3 CY (325BL)	02315 400 0300	2.01	/CY
Front-End Loader 5 CY (966G)	02315 400 1650	1.30	/CY
12 CY Truck, 1/2 mile Round Trip	02320 200 0320	3.09	/CY
On Site Disposal	02220 375 5550	6.80	/CY
Asphalt	02220 375 1750	6.20	/SY
Distance Disposal >5 miles	0220 375 5600	9.38	/CY
Steel Building	02220 100 0012	0.24	/CF
City Service	City Service Price	4.00	/CY
Haul, per mile over 8 CY Truck	02225 730 5100	17.20	/CY
16 Ton Truck	01590 200 5300	517.66	/Day
Truck Driver		38.10	/HR
Masonry Building	02220 100 0080	0.20	/CF
1 CY Skid Loader	02315 440 3020	10.92	/CY
Excavator, Diesel Hydraulic, 3-1/2 CY Operating Rate	Blue Book	53.15	/HR
Excavator, Diesel Hydraulic, 3-1/2 CY Rental Rate	Blue Book	15,130.00	/Month
Concrete Pump	03310 700 5350	19.75	/CY
Excavator, Diesel Hydraulic, 2 CY (325B)	02315 400 260	1.71	/CY
Backfill trench, 2-1/4 CY Bucket	02315 900 3080	1.55	/CY
Machine Placed for Slope Protection	02370 300 0100	27.45	/CY
Polypropylene Mesh, Stapled, 6.5 oz./SY	02370 300 0200	1.45	/SY
Drill and Blast Open Face >1500 Cy	02315 340 0010	8.29	/CY
D9R U-Blade ROPS Operating Rate	Blue Book	70.00	/HR
D9R U-Blade ROPS Rental Rate	Blue Book	17,590.00	/Month
815 F Compactor Operating Rate	Blue Book	31.85	/HR
815 F Compactor Rental Rate	Blue Book	9,064.00	/Month
613C Water Wagon Operating Rate	Blue Book	25.70	/HR
613 C Water Wagon Rental Rate	Blue Book	5,010.00	/Month
Truck Pickup 3/4 ton, 4 Wheel drive Operating Rate	Blue Book	7.40	/HR
Truck Pickup 3/4 ton, 4 Wheel drive Rental Rate	Blue Book	785.00	/Month
Foreman		39.60	/HR
Labor		36.50	/HR
Heavy Equipment Operator		47.15	/HR
Front-End Loader 5 CY (966G) Operating Rate	Blue Book	29.05	/HR
Front-End Loader 5 CY (966G) Rental Rate	Blue Book	7,095.00	/Month
12 CY Truck	01590 200 5250	19.90	/HR
Excavator, Diesel Hydraulic, 2 CY (325B)	01590 200 0300	33.90	/HR
Hydro seeding, seed, fertilizer, wood mulch	02920 500 1100	0.47	/SY
State Nursery		1.00	/Plant
Shrubs	02930 410 0200	6.05	/Plant
Storm Drainage	02630 100 2240	31.50	/FT
Water Line	02220 875 3200	4.96	/FT
Sewer Line	02220 875 3200	9.88	/FT
Backhoe-Loader	01590 200 0460	9.20	/HR
12-18 CY Truck Operating Rate	Blue Book	25.05	/HR
12-18 CY Truck Rental Rate	Blue Book	3,580.00	
Silt Fence	02370 550 1100	0.93	/LF
Chicken Wire	02820 500 0010	6.56	/LF
Crew B 13	Means Crew B 13	374.41	/HR
6000 gal to 8000 gal tank	02115 200 0310	225.00	/EA
Mixed Material Building, Large	02220 100 0100	0.26	/CF
Pipe Removal 12 inch	02220 875 2900	6.50	/LF
Excavating 2-1/2 CY hydraulic backhoe	02315 900 0620	2.58	/CY
ECDC	ECDC	35.00	/TON
Seal Portals	AML1	5,200.00	/EA
Fencing, barbed wire, 3 strand	0200 875 0600	1.36	/LF

Note:
Resources used were:
R. S. Means Building Construction Cost Data 60th Edition

Concrete Breakage

Concrete Demolition — 13.56 per cu. yd.

Powerline

1/3 the cost of a new line $1,550 plus $705 for labor and equipment divided by 5,280 feet. Personal communication with Means — 0.23 /FT

Powerpoles

1/3 the cost of a new pole $226 plus $51 for labor and equipment Personal communication with Means. — 126 /Pole

Ref.	Description	Cost
1	Mine Belt BC-1	18,333
2	Transfer Building	34,105
3	Feed Belt BC-2	12,941
4	Stack Tube (2)	4,436
5	Head House #1	6,233
6	Transfer Belt BC-3	8,254
7	Head House #2	1,567
8	Reclaim Tunnel	39,378
9	Reclaim Belt BC-4	11,599
10	60" Escape Tunnel	909
11	Crusher Building	30,113
12	Truck Loadout Belt BC-5	9,569
13	Truck Loadout and Scale	25,024
14	Bathhouse	126,051
15	Substation	1,920
16	Power Lines and Poles	2,884
17	Retaining Wall	844
18	Gabion Wall	55,822
19	Pump House	3,074
20	Paved Roads	53,439
21	Stream Culverts	45,702
22	Water Tank (2)	3,430
23	Rock Dust Bin	1,117
24	Fueling Station	1,610
25	Holding Tank (Sewer)	315
26	Ventilation Fan	2,146
27	Magnet	578
28	Water System	65,266
29	Sewage System	21,873
30	Trailers	6,112
31	Containers	9,160
32	Gilson Well	1,768
33	Shop Building	5,032
34	Switch Houses	1,128
35	Sampling System	1,472
36	Storage Building	1,950
37	Stoker Storage Bin	990
38	Substation No 2	2,849
39	Seal Portals	26,000
	Total	644,994

Ref.	Description	Cost
40	Cut and Fill Mine Site	311,921
41	Topsoil Placement	143,686
42	Stream Channel	108,250
43	Gabion Baskets	447
44	Refuse Site	64,042
	Total	628,346

Ref 44	Description	Materials	Means Reference Number	Unit Cost	Unit	Hourly Operating Costs	Hourly Equipment Costs	Operator's Hourly Wage Rate	Hourly Cost	Number or Men or Eq.	Total Eq. & Lab. Costs	Units	Quantity	Units	Production Rate	Unit	Equip. + Labor Time/Dis.	Unit		Cost
Refuse Site																				
	Structure Demolition Cost	Fencing, barbed wire, 3 strand	0200 875 0600	1.36	/LF								3250	LF			1.36	/LF		4,420
	Grading and Backfilling	D9R U-Blade ROPS Operating Rate		17,590		70.00	0.1	47.15	234.09	1	234.09	$/Hr	9887	CY	102	CT/Hr	96.9	hrs		22,683
	Subtotal																			27,103
	Spread Topsoil	Front-End Loader 5 CY (966G)		7,095		29.05	0.1	47.15	123.45	1	123.45	$/Hr.	36700	CY	203	LCY/Hr.	180.8	Hrs.		22,318
	Subtotal																			22,318
	Foreman							39.60	39.60	1	39.60	$/Hr.					277.7	Hrs.		10,996
	Truck Pickup 3/4 ton, 4 Wheel drive			785		7.40	0.1		13.05	1	13.05	$/Hr					277.7	Hrs.		3,624
	8,000 Gallon Water Wagon			5,010		25.70	0.1	38.10	97.66	1	97.66	$/Hr					277.7	Hrs.		27,125
	[illegible]																			[illegible]
	Total																			64,042

	Description	Materials	Means Reference Number	Unit Cost	Unit	Length	Width	Height	Diameter	Area	Volume	Weight	Density	Time	Number	Unit	Swell Factor	Quantity	Unit	Cost
45	Vegetation																			
	Soil Preparation																			
	Pocking	Excavator, Diesel Hydraulic, 2 CY (325B)	02315 400 260	1.71	/CY					14.56						AC		23,490	CY	40,168
	Subtotal																			40,168
	Fence																			
	Silt Fence	Silt Fence	02370 550 1100	0.93	/LF	7480										FT		6,800	FT	6,324
	Chicken Wire	Fence Chicken Wire	02820 500 0010	6.56	/LF	4500										FT		3,400	FT	22,304
	Subtotal																			28,628
	Seed Mix No. 1																			
	Hydroseed Equipment and Labor	Hydro Spreader (equip. & labor) B-81	Reveg005	19.95	/MSF					13.9						AC		605	MSF	12,070
	Hydroseed Material	Dugout Seed Mix No. 1	Dugout 07391	394.75	/AC					13.9						AC		13.9	AC	5,487
	Transplant Area No. 1																			
	Area										13.9					AC				
	Transplant Materials	Snowberry		0.66	EA										75	/AC		1,043	EA	688
		Utah Serviceberry		0.66	EA										75	/AC		1,043	EA	688
		Pinyon Pine		0.59	EA										200	/AC		2,780	EA	1,640
		Utah Juniper		0.66	EA										200	/AC		2,780	EA	1,835
	Transplant Labor	Bare root seedlings 6 to 10 inch, heavy soil		1.15	EA													7,645	EA	8,792
	Seed Mix No. 2																			
	Hydroseed Equipment and Labor	Hydro Spreader (equip. & labor) B-81	Reveg005	19.95	/MSF					2.45						AC		107	MSF	2,135
	Hydroseed Material	Dugout Seed Mix No. 1	Dugout 07391	362.25	/AC					2.45						AC		2	AC	888
	Transplant Area No. 2																			
	Area										2.45					AC				
	Transplant Materials	Narrowleaf Cottonwood		0.83	EA										250	/AC		613	EA	508
		Rocky Mountain Maple		1.00	EA										250	/AC		613	EA	613
		Willow		0.84	EA										4000	/AC		9,800	EA	8,232
		Woods Rose		0.55	EA										1000	/AC		2,450	EA	1,348
		Snowberry		0.66	EA										250	/AC		613	EA	404
		Utah Serviceberry		0.66	EA										250	/AC		613	EA	404
		Blue Elderberry		8.95	EA										250	/AC		613	EA	5,482
		Chokecherry		0.73	EA										250	/AC		613	EA	447
		Golden Current		0.66	EA										250	/AC		613	EA	404
		Carex Spp.		0.75	EA										500	/AC		1,225	EA	919
		Horsetail		0.75	EA										500	/AC		1,225	EA	919
	Transplant Labor	Bare root seedlings 6 to 10 inch, heavy soil		1.15	EA													18,988	EA	21,836
	Seed Mix No. 3 Refuse Site																			
	Hydroseed Equipment and Labor	Hydro Spreader (equip. & labor) B-81	Reveg005	19.95	/MSF					15.6						AC		680	MSF	13,566
	Hydroseed Material	Refuse Seed Mix No. 1	Maple Leaf	164.95	/AC					15.6						AC		16	AC	2,573
	Transplant Area No. 3																			
	Area																			
	Transplant Materials										15.6					AC				
		Black Sagebrush		0.40	EA										200	/AC		3,120	EA	1,248
		Schadscale		0.75	EA										200	/AC		3,120	EA	2,340
	Transplant Labor	Bare root seedlings 6 to 10 inch, heavy soil		1.15	EA													6,240	EA	7,176
	Subtotal																			102,642
	Revegetation																			
	25% Vegetation Rate																			25,661
	Subtotal																			25,661
	Total																			197,099

Productivity and Hours Required for Dozer Use

Earthmoving Activity:
Rough grading and backfilling

Characterization of Dozer Used (type, size, etc.):
Caterpillar Dozer D0R-9SU

Description of Dozer Use (origin, destination, grade, haul distance, materials, etc.):
Level grade, 21 feet blade width, 11.4 cu. yd. Capacity, 400 foot push

Productivity Calculations:

Operating Adjustment Hours =	0.85 x operation factor	0.8 x material factor	0.83 x efficiency factor	1.0 grade factor
	0.9 x weight correction factor	1.0 x production method/blade factor	1.0 x visibility factor	1.0 elevation factor
	=	0.51		

Net Hourly Production =	200 LCY/Hr normal hourly production	x	0.51 = operating adjustment factor	102 LCY/Hr

Data Source:
Caterpillar Performance Handbook - Edition 30

Productivity and Hours Required for Loader Use

Earthmoving activity:
Moving and spreading topsoil

Characterization of Loader Used (type, size, etc.):
Caterpillar Front End Loader 966G

Description of Loader Used (loading, geometry, materials, etc.):
5 CY bucket, haul distance 500 feet, -2% grade

Productivity Calculations:

Cycle Time	=	0.38 min haul time (loaded)	+	0.4 min return time (empty)	+	
		0.5 min basic cycle time	=	1.28 min		
Net Bucket Capacity	=	5 LCY heaped bucket capacity	x	0.95 = bucket fill factor		4.75 LCY
Hourly Production	=	4.75 LCY net bucket capacity	/	1.28 min cycle time	x	
		0.91 x efficiency factor		60 min/hr	=	203 LCY/Hr

Data Source:
Caterpillar Performance Handbook - Edition 30

CHAPTER 9

ALLUVIAL VALLEY FLOORS

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CHAPTER 9

ALLUVIAL VALLEY FLOORS

302-321 ALLUVIAL VALLEY FLOOR DETERMINATION

302-321.100 Scope of Investigation

The purpose of this Chapter is to provide to the Division the results of an investigation which was performed to assess the potential for an alluvial valley floor (AVF) to exist within the permit and adjacent areas of the proposed Dugout Canyon Mine refuse pile. The scope of this investigation has involved:

- Geologic studies (detailed in Chapter 6 of this Amendment);
- Hydrologic studies (detailed in Chapter 7 of this Amendment);
- Land-use studies (detailed in Chapter 4 of this Amendment);
- Soils studies (detailed in Chapter 2 of this Amendment); and
- Vegetation studies (detailed in Chapter 3 of this Amendment).

These studies are summarized in this chapter as they relate to the potential for existence of an AVF within the permit or adjacent area. The individual chapters outlined above should be consulted for more detailed information.

302-321.200 Summary of Studies Performed

Mapping of Unconsolidated Stream-Laid Deposits. RA Figure 6-1 presents a map of surface geology within the refuse pile area and adjacent areas. Included on this map are unconsolidated stream-laid deposits identified with map symbol "Qal". Note that the plans for construction of the refuse pile do not involve the removal or significant disturbance of alluvial fill.

Data presented in Section 728 of this amendment indicate that no significant impact to the availability of water in Dugout Creek is anticipated. Hence, the refuse pile will not result in a decrease in the availability of water to alluvium which has been mapped adjacent to the proposed disturbed area.

Agricultural Activities. As noted in Section 411 of this amendment and the approved M&RP, the only agricultural activities which occur within the permit and adjacent areas are grazing of range land. No irrigated agriculture occurs within the permit and adjacent areas.

Flood Irrigation. No flood irrigation occurs within the permit or adjacent areas. According to Section 411.130 of this amendment and the approved M&RP, the nearest area of irrigated agriculture is located approximately 4 miles southwest of the Dugout Mine.

Sub-irrigation. As part of the soils investigation discussed in Chapter 2 of this amendment, no water was encountered in the soil pits. No signs of mottling or other indications of a high water table were noted in the soils.

Flood Irrigability. Soils present in the proposed disturbed area are of limited thickness over much of the proposed site area. Some of the soils are also high in rock content. Additionally, the refuse pile area is located on the crest of one of the pediments with relatively steep slopes down to the alluvial fill areas, thereby isolating it from the alluvial fill.

Analysis of Aerial Photographs. Color infrared aerial photographs are not available for the area of the proposed disturbance.

302-321.300 Extent of Alluvial Valley Floors

Based on a review of the above studies, AVFs are not present within the proposed disturbed area, as indicated by:

- Flood irrigation or subirrigation of stream-laid deposits had not historically occurred within the proposed disturbed area; and

- Soil and topographic conditions within the proposed disturbed area preclude future flood irrigation of the site.

302-322 OPERATIONS AFFECTING DESIGNATED ALLUVIAL VALLEY FLOORS

Based on the information summarized in this chapter, no impacts will occur to designated alluvial valley floors due to mining and reclamation operations within the permit and adjacent areas.